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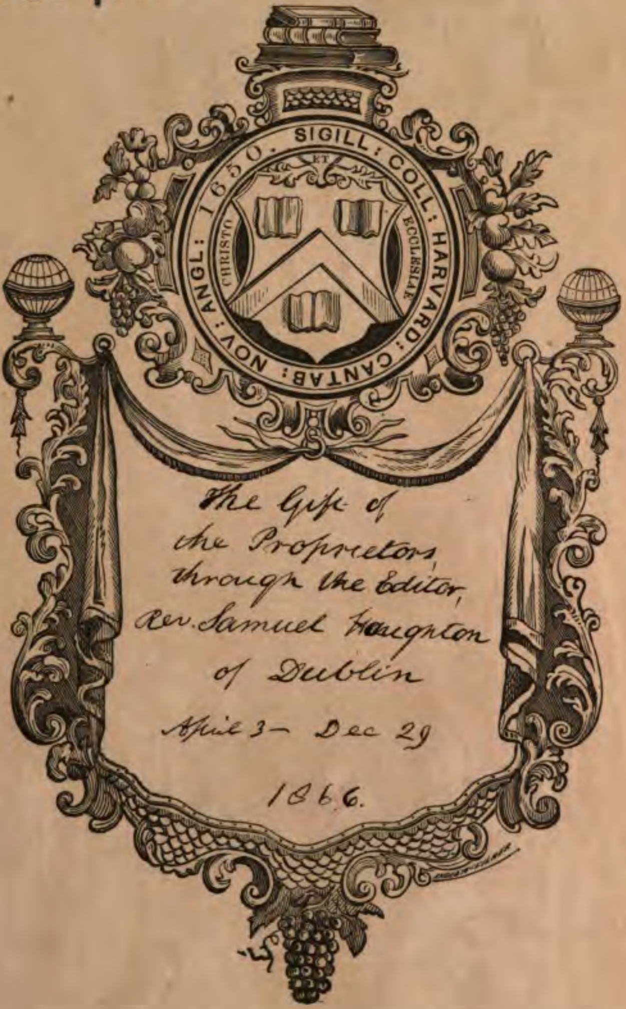
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◆

I.—On the Antiquity of Man. By John Locke, A. B., &c.

" Wast thou born before Adam?"—Job, xv. 7 (*Heath's Translation*).

[Read before the Royal Irish Academy, January 23, 1865.]

Certain writers assume a gradational progress from a natural condition of savagery to the ascendant intellect of the nineteenth century,—referring the aboriginal human animal, with his imperfect appliances of stone, horn, wood, and bone, to an indefinitely remote, *because* unchronicled era; but neither history nor experience furnishes tangible or reliable evidence in support of such an equably continuous developement, unbroken by retrogression and revolution. Declension from a state of comparative civilization to barbarism seems, indeed, cumulatively rapid; but of the converse—spontaneous progression *ab infra*, from savagery to civilization, apart from introduction of extern aid, or special supplement of Christian culture—we have no authenticated example. In fact, the theorist in archæology frames, however unconsciously, his own introspective notion of time as measured by an arbitrary sequence of developement in uniformly advancing series, and applies this imaginary rule unconformably to the past,* as if time itself were the generative cause, and not a mere passive condition of entities and events. He cannot legitimately summon geology to his aid in propounding the pre-Adamite existence of man, until experts in that science have welded geological to secular duration (if that shall ever be accomplished), by modifying the stratagraphical classification, intercalating a new, or filling up more definitely the subdivisions of a quaternary period; and extended palæontological observations tend rather to justify the induction, that the Pleistocene, containing associated relics of man and fossil remains of extinct animals, must be advanced within the Adamic epoch, than that the introduction of man upon our planet should recede into chaotic gloom, many millenniums beyond the genesis of Mosaical chronology.

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* The chronometry of some geologists is liable to a similar error of *uniformitarianism* in their theories of formation and modification of strata—forgetting that catastrophes, rarely occurrent within modern experience, have alternated in past ages more frequently and over wider areas with the imperceptible yet continuous processes of change; great physical cataclysms suddenly overwhelming or altering the geographical and geological aspect of vast portions of the terraqueous globe.

An apt illustration has been used to show the absurdity of estimating the duration of the past upon the basis of uniformity of geological change—*e. g.*—An adult attained his full height of six feet three inches by growth of one quarter inch during the last year, therefore he must be 300 years old; a conclusion not a whit more absurd than some numerical guesses at geological duration.

Again—Applying the observed numerical statistics of succession and increase to the antiquity of man, the solution will be found to confirm the Mosaical period of 6000 years since the creation of Adam. Exceed that period by even a small proportion of the hundreds of millenniums assigned by some to the past duration of our race, and then, making amplest allowances for all the checks to fecundity, inevitable, or fortuitous—war, famine, pestilence, death by physical accident, or by natural decay, and all the other ills entailed by sin and violence—nevertheless, man must have multiplied up to this date to such an extent as to render collective existence impossible within his present circumscribed domain, except the cumulative pressure of population was stemmed by a universal cannibalism, or that a wholesale exodus at stated periods to some other planet was found practicable. To such monstrous and absurd conclusions are those driven, who reject the evidence of revelation, history, and experience, for the wild inventions of an unchastened imagination.

The frequent occurrence of stone implements, unassociated with organic human remains, is obviously accounted for by their superior specific gravity to the soils on which they were originally deposited, and consequently their gradual yet persistent descent to the glacial or fluviatile drifts; while the lighter organic remains mingled in decay with the superficial mould. Aqueous infiltration, cuspidal form of the descending fragments, pressure of superinduced material, and the reciprocal effects of weight and adhesiveness, would all modify the rate of subsidence according to the comparative conditions in each instance; but down they go as surely as lead sinks in water; while the flying dust above, and that curious vegetable chemistry which abstracts carbon from the atmosphere, gradually increase the depth by continuous increments of surface covering. Had the late distinguished Chevalier Bunsen given due consideration to this simple fact, when he exhumed a few potsherds from the riparian silts of the Nile, it would have saved him the unprofitable toil of elaborating a chronology rivalling in extravagance the Egyptian myth of the pre-Adamite kings.

Again, where stone implements are found commingled with bones of animals, that had been subsequently delocalized by migration induced from climatic change—or of those extinct gigantic Pachyderms, of which the sole surviving link is the Auroch of the marshy forests of

Lithuania* and the Caucasus—the state of organic preservation even of the most decayed remains does not warrant a remoter origin than the Noachic deluge, and to which their miscellaneous grouping might be naturally referred. To adduce the most familiar example, the *Cervus megaceros* must have been living in Ireland at a period long subsequent to the Celtic and Iberian invasions, when the remnant of the subjugated natives, driven into the forests and peat moors of the interior, utterly perished with extinction of those animals that constituted their chief means of subsistence; for the skeletons are most commonly found imbedded in the lacustrine marl or calcareous tuff beneath the peat, and often containing much organic material. A centesimal analysis of a portion of one skeleton by Professor W. Stokes yielded 43·45 phosphates, with fluates, and 42·87 animal matter; and Professor Apjohn, after a careful chemical examination, states that "the cartilage and gelatine had not even been perceptibly altered by time" (Hart on "Fossil Deer of Ireland," p. 22–3). The Megaceros, therefore, must necessarily have been a contemporary of man far on in the historic ages; although from Herodotus to Cæsar, and thence to Oppian, there is no specific mention of this most magnificent of the ancient giant Pachyderms; nor even by native annalists, save a solitary and dateless tradition of the whole species having been swept away in one season by a destructive murrain.

The present or human geological era does not display the phenomena of new creations, but is distinctively characterized as well by the gradual decay and disappearance of those species least ministering to the necessities and uses of dominant man, as by the progressive melioration and sporadic increase of all the animals specially adapted to his service, comforts, and æsthetic choice; and this law extends also to the occasional displacement of indigenous Floras by introduced plants of a more utilitarian character.* Indeed, exaltation of type seems the one essential condition of continuity even with nature's grandest pattern, man; for, wherever improvement is arrested or undeveloped, extinction impends; and barbaric tribes either die out "without hand" in presence of their ascendant brethren, or the debasing characteristics are effaced in course of a few generations by assimilating intermixture with immigrant civilized communities.

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* It is impossible from the delineations of Ptolemy and other early geographers to define with any approach to accuracy the topography and extent of ancient regions and populations; and we shall probably find in Cæsar more reliable information respecting northern Europe than in any previous writer. From him we learn that the Hercynia Silva, a mingled wilderness of forest, mountain, and marsh, extending for sixty days' journey from the Upper Danube towards the Baltic, had been then unexplored; and that from its remote recesses occasionally issued huge beasts of strange form and fierce nature. The information is acknowledged to be only from hearsay, and bears the impress of exaggeration; but he describes at least one animal, which we can identify with a surviving specimen, the Auroch—*Bos urus*—(Cæsar, "De Bell. Gall.," l. vi., 24, 25). Now, assuming that the Hercynia Silva and similar unexplored regions stretched along the banks of the Theiss (Tibiscus), and thence northward into Lithuania, we have at this day an outlying remnant of those ancient Silvas affording shelter to at least one of the huge brute proprietors that roamed through its shades 2000 years ago, and whose descendants are now preserved by stringent forest laws in the primitive forest of Bialowitz, in the province of Grodno, part of the ancient Lithuania.

In the museum at Pesth is deposited a large collection of skeletons of the ancient monster mammals—Bovine, Cervine, Elephantine, &c.—in a sub-fossil or unpetrified state, collected chiefly from the alluvial basins of the Theiss and other tributaries of the Danube. There are the bones of the *Bos urus* (still existing), and of the rein deer (now delocalized by migration from a climate grown unsuitable to its habits), associated *in situ* with the extinct *Cervus megaceros*, *Elephas primigenius*, *Rhinoceros tichorinus*, and many others, including, as I have been informed, some which are usually referred to a long anterior era; so that we may reasonably infer the coexistence of all in the comparatively modern age of the renowned hero and historian, Julius Cæsar. See also allusion to the Hercynius Saltus in the "Germania" of Tacitus, sect. xxx., and Latham's "Prolegomena," p. 107.

According to the testimony of Pentateuchal history, happily as yet unshaken by "the controversies of a counterfeit science,"† civilization was the primitive condition of man. The metallurgy of "brass (bronze), and iron," was known even within the Adamic epoch,‡ and consequently must have been transmitted to post-diluvian ages by Noah and his family; for the ambitious attempt at centralization in the plain of Shinar betokened cultivated acquaintance with the constructive arts; nor does there appear any warrant of disproof that the primitive fabricators of stone, bone, and horn implements were but outcast remnants of that "one people," which, under the constraint of Divine appointment, had "been scattered abroad upon the face of all the earth,"§ whose moral degeneracy precipitated their physical deterioration, until, becoming feeble and timid, they were pitilessly driven by subsequent immigrations of more powerful tribes into rocky deserts and forest fastnesses, without the means and appliances of civilized life. Job,‖ fifteen hundred years before Christ, gives a graphic description of a certain Pariah race¶ who had probably been ejected from their primeval seats by the warlike princes of the Ishmaelites and the fierce and restless dukes of Edom; and it is curious to observe how accurately this passage in the book of Job accords with the account of the Troglodytes a thousand years after his time by Herodotus.**

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* See an interesting account of displacement of certain indigenous plants of New Zealand by intrusion of European grasses and weeds, in a letter to Dr. Hooker from an accomplished naturalist, W. T. Locke Travers, F. L. S., &c., in "Natural History Review" for October, 1864.

† 1 Tim. iv. 16—see original.

‡ Gen. iv. 22.—The earliest notice after the Deluge of mining and smelting metals is found in Job, xxviii. 1-11, describing, in sublime and poetic language, hydraulic and other operations of mining on the grandest scale.

§ Gen. xi. 8.

‖ Job. xxx. 1-11.

¶ The Sukkiim (סֻכִּיִּים, 2 Chron. xii. 3), who swelled the invading host of Shishak, is rendered in the Septuagint, *τρωγοδύται* (? *τρωγλοδύται*), and in the Vulgate, Troglodytæ—manifestly an incorrect rendering in both versions. The Hebrew word signifies "dwellers in tents, or booths" (not caves), and probably designated a warlike nomadic tribe of Ishmaelite descent. The abject and feeble Pariahs would have been an incumbrance, rather than an efficient auxiliary to an army numbering 12,000 chariots and 60,000 horsemen, besides footmen "without number."

** Melpomene, sect. 184.

Certainly the 730 years intervening between Babel and the Patriarchal era of Job afforded ample interval for the rise and decadence of numerous peoples, whose existence the Mosaical history of the chosen nation notices only by the brief record of a name, and who had been swept away by the devastating sword of successive revolutions, as diversified and destructive in their effects as those physical changes produced by the fiery deluge that overwhelmed the cities of the plain. Migration on a world-wide scale prevailed even during the Noachic age. Thus Cush, the grandson of Noah, is described by Sanchoniathon* as a colonizing monarch, traversing the earth; and these waves of population surging from the Mesopotamian plains, and again in subsequent ages refluent upon their former tracks, would inevitably tend to create certain residual and stagnant eddies (as it were) of the primitive settlers in all the intermediate regions.

The unhewn megalithic structures,† scattered over all lands from farthest East to remotest West, furnish a "testimony of the rocks," more enduring and significant than any extant historic record, of the invading as contradistinguished from the primitive colonizing migrations. The Menhir of Brittany and the Irish Gallaun are but Gentile analogues of the pillar set up by the Patriarch at Bethel.‡ Now, these Oriental outswarmings succeeded each other at irregular intervals, and over unequal extents, until the commencement of authentic Greek and Roman annals, when Scythian, Scandinavian, and other Northern hordes rolled back the tide, combining in their turn to produce similar debasing effects among those settled populations, that had in former ages migrated from the East. Indeed, civilization and savagery appear in contemporary contrast in every era and in every clime, and the phenomenon of a decivilized people, dwarfed alike in mind and body, is not the peculiar characteristic of any one country or dispensation. In Europe, although the Pariah tribes have disappeared, except perhaps in the instance of the Cagots of the Pyrenees, yet their former existence in great numbers is clearly inferred from the vast quantities of stone implements and other rude remains strewn upon the diluvial gravels, or exhumed from ancient shell heaps, pile dwellings, and ossiferous caves, or swallow holes—and elsewhere throughout the world, especially among the low castes and hill tribes of India, in the central forests and sundry remote islands of the Pacific Archipelagos, in the Fuegian peninsula, and in the interior of Africa, where Strabo* found the descendants of those cave dwellers described by Herodotus 500 years before, remnants of degenerate and outcast races survive to this day; and traditional myths of their archaic derival and primitive social condition are extant in the literature of the more powerful immigrant tribes, who drove them from their aboriginal seats into forests and solitary places; but among the lapsed races themselves not a trace of history or tradition has been discovered, on which to base even a proximate conjecture of their origin in circumstance or in time.

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* Eusebius, l. i.

† In the Pentateuchal histories these unhewn structures, monolith, trilith, or of more complicated form, are described as set up for various purposes—altars, sepulchres, boundaries, testimonials of triumphs, covenants, deliverances; but when the purity of Patriarchal Theism was polluted by idolatrous admixture, so that the symbol itself came to be worshipped, injunctions were issued under the Law and the Prophets to destroy utterly all such monuments. The command, however, was but partially obeyed until the return from the Captivity, from which period to the close of the brief Asmonean dynasty the iconoclastic ardour of the chosen race left scarcely a vestige of the numerous megaliths that once marked with their uncouth figures all the Syrian hills and plains. In other regions, especially of Northern Europe, where the earlier Oriental colonists had erected Cyclopean structures after their ancestral fashion, no such styloclastic zeal was evinced; and even upon the introduction of Christian missions these rude memorials were not only preserved intact, but it was sought to evangelize the stolid and superstitious idolaters by grafting pious figments on what seems to have been the earliest and most debased phase of a material idolatry; for the primitive graven image is not described in the Bible as essentially distinct from the stone pillar (see Deuteronomy, vii. 5, and marginal references, in the original).—In the Celtic languages the word for idol, which is usually applied to the rude monolith, is exactly like the Hebrew word both in etymology and sound. For example:—The Irish word Ioṁaiġ (Eevau), and the Hebrew, אָוֶן (Eevan), both signify *idolum*, *vanitas*, *nihilum*; and thus St. Paul's definition receives an expressive confirmation (1 Cor. viii. 4) where he terms an idol *οὐδὲν ἐν κόσμω*—"nothing in the world"—a vain semblance of that which has no existence. See some curious notices on this subject by the writer in "Belfast Archæological Journal" for October, 1853, p. 303; and "Notes and Queries," 1853, p. 413; and second series, No. 62, p. 194; together with the Articles referred to therein.

‡ Gen. xxviii. 18.

In Australia at the present period we observe on a continental scale the contemporaneity of an intruded civilization with the phenomena of what archæologists term the Stone era; nevertheless the latter possesses no chronological significance whatever; and scientific theorists may well pause and ponder, ere they construct an imaginary series of gradational progress from an unchronicled antiquity, when they contemplate the myriads of these Papuan savages, with flint weapons and prognathous aspect, in contact with an unparticipated civilization, uncheered by the presence and unimpressed by the example (save as to debasing influences) of the superior race; and these contrasted conditions, too, exhibited in association with an indigenous Flora and Fauna, characteristic of an era indefinitely withdrawn in the succession of geologic time. In absence of sufficient proof of extreme antiquity, *non-historic* or *unhistoric* would be a more appropriate term for the Cave-men and Lake-dwellers than *prehistoric*, in reference to the question of chronology.—Mystery ever attaches to the unknown; and where the darkness of oblivion rests upon the pristine homes and habits of a vanished people, imagination busily fashions into long periods the unrecorded past. It may also be observed, that this negation of the historic elements does not *necessarily* imply a state of savagery. We infer the civilization of Aztec and Etruscan respectively from elaborate sculptures and mortuary memorials, or domestic utensils of elegant design; yet these, like the fossil organisms of the rocks, supply no key of historic interpretation, and the inscriptions are in a language utterly lost; so that no intelligible record survives of the annals, origin, or social condition of these highly cultured peoples, nor yet of their more famous predecessors, if not indeed founders, the Phœnicians, who for more than 1500 years after the dispersion from Shinar unceasingly extended their arts, religion, and literature, to all shores accessible by their enterprise and commerce. The testimony of a Roman historian may here be aptly introduced in illustration. The populous state of the Veientes, renowned and powerful long before Rome was founded ("Civitas antiquissima Italiæ atque ditissima," Eutropius, l. i., s. 19), had been utterly destroyed by the arms of the advancing Republic, 399 B. C.; and Florus, only 500 years after, in the reign of Trajan, thus apostrophizes the Veientes—"Fuisse quis meminit? Quæ reliquiæ, quodve vestigium? Laborat annalium fides, ut Veios fuisse credamus."* Within the short space of five centuries, and in a comparatively civilized era, oblivion had swept away every vestige of this renowned Etruscan people, so that even their former existence seemed dubious, and their magnificent cities, like Veii, as if they never had been.

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* l. i. and xvi.

As for the guesses of those sciolists, who, regardless of the Divine afflatus which constituted man "a living soul" (Gen. ii. 7), if not likewise of his distinctive organic structure, have invented the priscan, *alias pithecoid* man, for the purpose of demonstrating the pre-Adamite antiquity of the human family—pronouncing a solitary exceptional instance of an abnormal skull (it may be idiot or cretin) to be the type of a species, and thus rounding off the transmutation series from Mollusc to Man at the superior end—now, in Australia, if anywhere, the missing link might be confidently sought; for there the aboriginal Papuan presents the most debased form of the human organism; yet it so happens that the Simiæ are not found, either indigenous or fossil, the Fauna of that region indicating a geologic era many thousand years anterior to their appearance on our globe. It is difficult to believe that Anthropologists are really in earnest in propounding this strange theory; however, there is no accounting for tastes, and the pride of ancient ancestry sometimes assumes an amusing perversion. The Simian advocates may easily test the conditions of their fantastic thesis by organizing an expedition to the banks of the Gaboon,

> "Where wild in woods the noble savage *runs*,"

not for the purpose of skinning their hirsute cousins, like Hanno, or du Chaillu, but of introducing social reform, and educating them up to their own standard of rational accountability. Doubtless the civilized Orsons of Gorilla Land would hereafter move respectably on all-fours in *anthropomorphological* circles, and in due time be enabled to enlighten their scientific patrons and the public on the genealogy and habits of *pithecoid* or priscan man.

The Museum at Bern presents probably the most complete collection of primitive rude implements of human manufacture, discovered in the ancient lake dwellings of Switzerland (in Ireland termed Crannogues), where these had been exposed by an unusual subsidence of the water levels; the cushion of still water beneath the frozen or wind-moved surface having preserved from oxygenating waste and atmospheric wear and tear numerous relics of what are assumed to be successive stages of well-defined progress from an aboriginal savagery to civilization; although, indeed, these may have existed contemporaneously under diversified conditions of isolation and physical privation. However, admitting the succession of epochs, they may be consistently included within the historic period of Helvetia, as known to the Greeks and Romans, from the pre-Christian irruptions of the Teutones and Cimbri to the Gothic and Frankish invasions of the Gallo-Roman era. During this stormy interval of 700 years the central highlands of southern Europe, situate as it were in the very axis of revolutionary transit, sustained the convergent pressure of warlike and antagonistic races. The Romans unceasingly pressed upward from the south along the Alpine streams and passes; while barbarian hordes successively, or in confederate bands, overflowed from north, west, and east, tracing their devious paths by the great fluvial highways of those forest-covered regions, along the courses of the Rhine, and Upper Rhone, and through the valley of the Inn from the vast and populous basin of the Danube. Thus the Helvetians (both aboriginal or descended from the primitive replenishers* of that region, as well as those of mixed colonial blood of Etruria and Rome) were swept by every recurrent wave of invasion from their cities and settlements in the fertile intra-Alpine vales into the inhospitable mountain districts; again driving before them with unsympathizing rigour, into fastnesses still more remote, the Pagani, or less civilized populations on the outskirts of their respective territories. Mercy for the feeble is the attribute only of a long-sustained moral and intellectual culture; and these despised outcasts, hated for their very harmlessness, and rifled of their weapons and all appliances of industrial acquisition or improvement, hid themselves in solitary caves of the rocks, or constructed in unexplored localities rude insular dwellings as a frail nocturnal protection against wild beasts, with whom they waged a dubious strife in the struggle for existence. Fear on their part, with aversion on the part of their enemies, would tend to continue, as well as aggravate, this compulsory exclusion from all advantages of civilization; thus stereotyping, as it were, the superinduced savage state, by closing every avenue to functional developement of mind and body. No diligent student of human nature will deny that a persecuted and inopt race,† under incessant endurance of hunger, cold, and terror, must even within the lapse of three or four generations become almost hopelessly deteriorated both intellectually and physically, losing, together with the intenser vitality of soul, all memory of the history, arts, and social condition of their progenitors—no desire, save the satisfaction of instant animal wants—no audit of time beyond the changing season, or the passing day; for time must be a pure negation to those who are incapable of applying thereto the measure of ideas and incidents in intellectual progression.—Alike unheeded as unchronicled by their oppressors, thus existed and passed away, thus now survive, yet decaying before our eyes, the degenerated tribes of the human species.*

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* l. i. c. 12.

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* Gen. x. 5.

† Distinction must be made between these timid and proscribed Pariahs and the early colonists of high latitudes, whose very climatal disadvantages kept them apart alike from the improvements and obstructions of a dominant civilization. There is every

It is submitted that, conceding their due value and significance to the discoveries of geologists and archæologists, the phenomena adduced up to this date do not afford adequate evidence in demonstration of the universality of the (so-termed) Stone era, or that it antedated civilization upon our globe; and both sacred and secular history accord with human experience in authenticating, first, the Mosaical limit of 6000 years since the creation of man; secondly, that civilization, not savagery, was his primitive condition; and, thirdly, his utter incapability of self-renovation from moral and physical decadence, apart from extern aid and instruction.

From the days of Adam even to the ascendant enlightenment of this nineteenth century of the Christian dispensation, civilization and savagery have dwelt together upon the earth, associated, although in contrasted aspects; and their continuance, without coalescing, awaits the solution of the providential, not *geologic* future.

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probability that a thousand years before the Christian era, and therefore strictly within the domain of secular history, icebergs not only stranded on the coasts of the Baltic and North Seas, but were launched even from glaciers formed in the maritime glens of Wales and Scotland; and that in the littoral regions of the British Isles, Denmark, and Northern Germany, dwelt many scattered tribes, of whom we have obscure intimations in the earlier semi-fabulous annals, as being clad in the skins of animals slain by their rude primitive weapons, and dwelling amid ice and snow, like the Esquimaux of our age. This view receives accidental confirmation from the bones of the *Alca impennis* (great Auk) having been lately discovered in shell mounds in Caithness, which would imply a sub-arctic climate in Scotland during the so-termed Stone era, when feeble communities of men dwelt in isolated localities along the coasts, and giant animals (now extinct) roamed undisturbed through the marshy plains and forests of the interior.

That climatic improvement may be effected to a considerable extent, independently of physical revolutions, by the slow yet persistent agency of man, in felling forests, draining marine and lacustrine marshes, and confining rivers within their courses, is exemplified (to quote but one instance) in the elevated mean temperature of the New England states within the two centuries and half since the "Mayflower" touched the American shore: how much more, then, must the climate of Northern Europe have been improved under similar agencies for well nigh twenty centuries!

* The "Hobart Town Mercury" of 20th October, 1864, states that the only survivors of the Tasmanian aborigines then in existence were one man and three women; "the latter not being of such an age or appearance as to justify the expectation of any future addition to their number;" so that the whole race may now be deemed extinct within the brief period of sixty years, notwithstanding humane exertions to preserve the remnant. See papers on "Discoveries in Australia," in the "Dublin Quarterly Journal of Science," for 1861, '62, and '63.

II.—On the Neglect of Sanitary Arrangements in the Homes and Houses of the Rich and Poor, in Town and Country. By Evory Kennedy, M. D., E. & Dubl. (Hon.); Fellow and past President of the King and Queen's College of Physicians in Ireland, &c.

[Read before the Royal Dublin Society, February 23, 1865.]

Let us ask, What is the necessity for dealing with our present subject? Dr. Guy's calculation of the mortality in large towns, published in 1846, furnishes the best answer. Take the average healthy standard of mortality in these at 1 in 45, and compare it with the absolute general standard of mortality, 1 in 50. This leaves an excess of two per cent. of what may be termed unnecessary deaths, or 8000 in every 1,000,000 inhabitants. This would make in the three kingdoms an annual unnecessary loss of 60,000 lives. Then take Dr. Playfair's calculation, that for every death there occur twenty-eight attacks of sickness, or cases of morbility. That would give $1\frac{3}{4}$ million of cases of unnecessary sickness; but say we place it at one million, the result of a different method of calculus, all of this million, with its incalculable suffering, torture, grief, and misery, might have been prevented! What an appalling consideration is this to us as responsible members of society! But, as some of us cannot be aroused to think of anything that does not touch our pockets, I may state the money loss to the community resulting from this morbility and mortality to amount, according to the best authorities, to nearly £20,000,000. Another way of looking at the matter is, the comparative mortality of the gentry and labouring classes in certain streets in some of our cities, say in London; the average life of the former being forty, whilst that of the latter is only seventeen years—that is to say, they lose twenty-three years of their lives, one with another. I do not envy the selfish member of society, who, with a knowledge of this fact, can look on with tacit indifference at such a disproportion in the enjoyment of God's great gift of life—a gift thus wantonly cast away through man's mismanagement.

In considering the important subject of sanitary reform, the conviction must come home to every thoughtful man, that, without delaying to accomplish great things, such as now occupy so much public attention, there is much to be done towards lessening mortality, and improving the health of the community, by attention to smaller matters, within the reach of every man. The neglect of these is daily fraught with the developement of disease and death in this metropolis and throughout the country. Whilst we are perhaps engaged in concentrating our attention upon those general sanitary improvements, such as now, at the eleventh hour, force themselves upon the attention of our legislators and civic authorities, let us also exert that home care and solicitude that not only tell more immediately, but, I hesitate not to add, more effectually, in the prevention of disease than all the steps that can be adopted by the public authorities. What signifies it to me, as a father of a family, responsible for the safety and health of my children and domestics, whether the system of public sewage be the most perfect and complete, if my house, through my own neglect or ignorance, be a receiver for the noxious gases with which these sewers are charged; or what do I gain by the establishment of a system, which, although it purifies the atmosphere without my house, breathed by my family for perhaps two or three hours a day, yet absolutely concentrates within my house the noxious effluvia inhaled by my family for twenty-one hours each day? At night, also, it must be recollected, the body is more susceptible of disease, and the doors and windows closed; thus concentrating those poisons most when we are sure to be exposed to them under the greatest disadvantages.

As my object in the following paper is to afford a few practical hints to householders and heads of families, I shall endeavour to convey myself in the most simple language, avoiding all technical terms and scientific display. If my more scientific hearers should, as no doubt many of them will, pronounce the subjects treated in it as trite and commonplace, I shall admit the impeachment, and merely answer that my object is to render them still more so. Although amongst the enlightened individuals surrounding me there may not be one sentiment announced or one principle propounded with which you are not familiar, and of which, in the words of the philosopher, as applied to geology, you may still know nothing "that it would not be a disgrace to an English gentleman to be ignorant of," yet experience of the habits of the rich and the poor in this city and country have left the conviction on my mind that they require to be inculcated and insisted upon, as the simplest sanitary and health-procuring principles are totally neglected amongst them individually, and consequently that our disease and mortality are greatly increased from this neglect. I need only refer to our weekly returns to establish this conviction in your minds also.

We talk of the filthy exhalations that pervade the hovels and crowded lodgings of the poor, and with great justice, as these demand our closest attention; but we little dream that the atmosphere breathed in some of our most respectable houses, nay, in many of our most stately mansions, is as foul, as fatal, and as deadly as that in the houses of the most wretched of our population. Full often have I traced to this cause disease that undermined the health and paled the cheek of the junior members of some of our most refined and highest families.

SEWERAGE.

Let us now see how this occurs. Nearly every house is provided with a sink, or receptacle for slops, which communicates with the general sewerage of the city through a special or branch sewer that leads from each house, and which generally traverses the basement. These sinks are, in some cases, in the kitchens; in others, in sculleries, or small chambers attached to the kitchens.

The air that pervades the sewer is cold, that which occupies the kitchen is hotter, therefore of less specific gravity, or, in plain language, lighter. The tendency of the lighter air is to float upwards, and the result is that the cold air rushes up to replace the vacuum thus formed. The effect, then, of allowing a communication to exist between the sewer and the air of the house is obvious. The heated air of the kitchen is constantly rising until it reaches the highest apartment in the house; as it does so, it is replaced by the colder air from the sewer, loaded with its poisonous gases. In other words, the house becomes a chimney to the sewer, through which the foul atmosphere is exhausted, in addition to its being a generating laboratory developing its own supply. This, I regret to say, is the case with a large proportion of the houses of the rich, as well as of the poor in this city. The cure for this generally had recourse to is, flushing out the sewer, or lifting the cover of the house sewer and cleaning it out. Both of these expedients, although beneficial, add to the fœtid exhalation for the time, and disappoint the house occupier by leaving the nuisance afterwards where it stood, or worse. What every housekeeper should look to is the preventing any possible return of noxious air, by cutting off the communication for gases between the house sewer and the house, but retaining the communication for fluids or slops. This is done in the simplest manner, at the expense of a few shillings, by interposing between the sink or slop trough and the house sewer a water valve, which admits of the escape of fluids, but prevents the return of gases. Let me request every man who hears this to walk down to his scullery, light a candle, and hold the flame of it directly over the opening leading from the sink trough to the house sewer; and if the flame of the candle be blown up perpendicularly by the rush of foul air, let him immediately have a water valve interposed. But let him recollect that if a rat-hole remain, keeping up a communication between his house and the general sewerage, he is still exposed to the influence of the poison.

SEWAGE IN COUNTRY HOUSES.

Let not our apparently more favoured neighbours who reside in the healthiest localities in the country districts imagine that locality alone secures them an immunity from the disease and mortality ascribable to neglect of the precautions here insisted on. True, they may plume themselves with the idea that they are far removed from the murky atmosphere above, and the noisome filth rivers beneath, that pervade city districts. But I grieve to say that I have frequently been stifled with the sewerage exhalations that have met me on stepping into country houses placed in the most salubrious and enviable positions. Infantile intermittent was, insidiously perhaps, doing its work of death in their admired retreat. The astonished parents, who had laid out thousands in embellishing their charming villa or mansion, were horrified with the announcement that the air of their paradise was poisoning their child, and that the only hope of saving it was an immediate change. On searching into the cause of this, a cesspool perhaps tastefully covered over in the parterre, or an escape from the sewer saturating the earth on which the house rested—perhaps an open-mouthed filth channel, causing an increase of stench on change of wind, but always securing a poisonous admixture in the house atmosphere through its untrapped sink or slop receiver—was the cause of the worm in their gourd.

Let us, then, also advise our country friends to apply their candle to their sink and slop openings; to trap them, if necessary; to see that their sewerage is perfect, and if not, to lay down earthenware pipes at once to receive it. Let them look to their cesspools; if within three hundred yards of their houses, let them fill them up, and open new ones at that distance at least, securing, if possible, a good fall and an ample supply of water to carry off the solid matter. By lining the cesspools with cement they may be rendered economical, and subsidiary to farming or gardening uses.

The use of earthenware tubes for carrying off house sewage is one of the greatest practical improvements in modern domestic architecture, and should be had recourse to in all cases where it is necessary to renew or originate sewers.

However carefully prepared the masonry sewers may be, escape of the fluid contents will occur; rats and other vermin will open communications with them in course of time, and, the fluid contents of the sewer welling out, the clay of the basement story is converted into an earth sponge of poison-exhaling vapours, undermining the health of our domestics, who usually reside in them, if it do not also extend its influence to the family in the upper chambers. I had some years since an opportunity of examining a case of this kind in a spacious mansion in which I desired attention to be paid to trapping the sinks. This was done, but still the inconvenience remained, attended with an unpleasant exhalation in the basement story. The sewers were then examined, when it was found that these, which had been built a long time, were permeated with rat-holes, through which the fluid escaped freely at several places, but particularly at one place—directly under the boarded floor of the sleeping room of the butler, where a floating mass of several tons of liquid of the consistence of thin treacle rested upon the earth, which was throughout the base of the house thoroughly saturated with the constantly escaping liquid. Chloride of lime was thrown down, earthenware pipes substituted for the old house sewer, with a good fall to the main drain, when all inconvenience was removed, and the house was rendered healthy.

It is to be observed that suburban residences are generally in a worse position as regards sewage than those either in town or country, as they rarely can avail themselves of the main sewers of the cities, and are unprovided with substitutes.

I regret to state, a large proportion of even the most enlightened members of society are in ignorance of what becomes of the sewage of their own houses, whilst any public measure calls their energies into immediate activity. Would that their charity would begin at home. Would that the population of this city could be induced to pay a tithe of the attention they devote in studying the merits of the general sewage of Dublin, which, albeit capable of much improvement, is by no means in the deplorable state represented, to securing the simplest and most obvious sanatory arrangements in their own houses.

CONTAMINATION OF PUMPS AND WELLS.

My attention has been drawn to more than one instance in which the foulness and fœtor of the water drawn from the pumps led to the discovery that the well and an imperfect house sewer or cesspool were in close proximity. There is no excuse, with our recent improvements in the street sewers of this city, which reflect the highest credit on their managers, for the continuance of such private, nay, we may say public, nuisances. The corporate authorities afford spacious well-trapped sewers within a few feet of our hall-doors with ample fall, and every facility for availing ourselves of them.

Where a main sewer does not at present exist, the inhabitants of the locality have only to call for it; yet, I regret to say, the proportion of houses in which no connexion with the improved main sewer has been established is incredible. I could mention one fashionable street, containing about thirty houses, in which only three houses have communications with the newly constructed main sewer. Those who have not such connexion are dependent upon imperfect sewerage, laid upon old and defective levels, upon open ditches, or upon cesspools. These should be looked to by the police as a public nuisance, on the principle of their poisoning the atmosphere and the soil.

Whatever originates zymotic or infectious disease is a public nuisance, and the accumulated evidence of the most reliable authorities tends to the conclusion that they do so. Zymotic disease is doubly a nuisance; first, in its production, which is unfortunately not confined to the sordid or negligent man who called it out; but, secondly, from its extension through contagion, which allows of no limits to the mischief it may inflict. One citizen takes every pains to render safe not only his sewerage, but to have the purest drinking water. He sinks a pump seventy feet through the bed of limestone gravel on which we sit, and taps his neighbour's leaking sewer, manure heap, or cesspool, in the process. Or perhaps his predecessor has had a well which for fifty years has been the pride of the district; his neighbour neglects his sewerage, or allows his surface water to wash the contents of his ashpit or cloaca into the soil close by, and he finds his drinking water charged with sulphuretted hydrogen. The negligent neighbour poisons the inhabitants of the street by not trapping his surface water sewer, and by the nuisances in his area, although the city authorities possess ample powers to correct these, and have gone to large expense to trap the public sewers most effectually.

We are not, however, to suppose, strong as the evidence may appear when sulphuretted hydrogen is found in water, that animal excrement has entered the well. I send you round a specimen of water in which no such cause could be assigned, and yet the waters of Harrowgate are not more charged with it. This is ascribed to the insertion of a pump made of Memel timber some months before the gaseous poison was detected. The water, I should mention, was perfectly pure for eight years before the insertion of the Memel pump; nor is this the only case that has come to my knowledge of such a result from a Memel pump. I have submitted this matter to the investigation of Professor Barker, whose admirable paper read on the subject of "Water" before our Society renders quite superfluous my dealing with this important branch of my subject further. I doubt not he will furnish us with an explanation of this phenomenon.

CONTAGION, HOW DISSEMINATED.

Whatever precautions we may take in our houses, there can be no security against the spread of epidemic or contagious diseases, if proper police regulations be not insisted on in places where the upper as well as the lower classes must be exposed to their influence. This raises the question of our public assemblies, churches, courts of justice, theatres, and other buildings, our hotels and lodging houses for rich and poor, and our public conveyances. It is difficult to reach the case of people frequenting churches and other public assemblies charged with infection; and a moral conviction of the impropriety of spreading disease and suffering, perhaps of inflicting manslaughter, through their want of the application of the golden rule, must, I fear, continue the only check to the practice.

In Continental countries it is not found impracticable to bring the proper management of the hotels and lodging houses for the rich, as we do those for the poor, under police control. In some towns in Germany and Switzerland, the hotel keepers are obliged to report zymotic cases to the police authorities; and within the last few months a patient whom I had sent to travel for health in Switzerland, and who was attacked by small-pox, was removed by order of the police to the public hospital at Zurich—was admirably cared for in a private ward, and, I have little doubt, enjoyed greater advantages than in the hotel. Whatever difficulty may occur in meeting the spread of contagious diseases in lodging houses and hotels, there ought to exist none in the case of using public vehicles for the transmission of infectious cases. This, I regret to state, is a practice constantly adopted in this city—adopted as a matter of necessity—as, unless for the Cork-street and Hardwick Fever Hospitals, there is no vehicle attached, as there should be, to the hospitals, and the only alternative left is using the public conveyances. I think it my duty to call the attention of those whom it may concern to the correction of this fruitful means of disseminating disease, merely premising that until the governors of hospitals provide ambulances, or other suitable conveyances, it is needless that the police prohibit the practice referred to.

SMALL-POX.

The wise step taken at last by our legislature in rendering compulsory the practice of vaccination, having broken the ice of that frigid and mistaken axiom of "not interfering with the rights of the subject," even to save his life, we may hope to see other sanitary measures of a compulsory nature to follow in its wake. Rights of the subject! Is small-pox a right of the subject? I ask you as enlightened men, and, I doubt not, members of the community sturdy for your rights, whether our legislators best consulted your interests by maintaining for you in all its integrity the right of having small-pox, or by yielding ungraciously to the importunity with which we for many years tortured them into an acquiescence in the Compulsory Vaccination Act? And, although we could have modified the Act in some respects, I speak the opinion of my brother directors of the Cow-pock Institution when I state that we look forward with confidence to this measure, when long enough in operation, as a means of exterminating small-pox, unless when imported. There is strong reason to suppose that its recent appearance in Dublin was due to this cause, as it was traced to the arrival of a regiment from an infected district. Its occurrence in this way seems to be one of those exceptions that prove a rule. The great Jenner himself anticipated this in his letter to Sir Charles Morgan, in 1811. "The small-pox (he says), if it now and then seizes upon some deluded infidel, soon dies away for want of more prey." I am happy to add, his views are in the present likely to prove as true as in former attacks, as the disease appears again "dying out for want of more prey." Attention to ventilation and sewage in the lodgings of the poor, and the non-transmission through our public vehicles, will further assist its extinction.

VENTILATION.

We have been hitherto dealing with the exclusion of foul air from our breathing atmosphere. But the atmosphere is not merely vitiated by sewage exhalations. The constitution of man himself is such, that his presence necessarily poisons or vitiates the atmosphere in which he exists. The due performance of the functions of breathing and exhalation from his surface abstracts from the atmosphere certain of its constituents, and imparts to it other qualities that render a given portion of the atmosphere, if stagnant or shut off from fresh supplies, ultimately incompatible with human life; man may thus be said to perpetrate the suicidal paradox of self-murder by persisting in living. In the construction of our new, and in the arrangements of our old houses, then, we must look to it that a sufficient provision is made for changing the air we breathe; in other words, for allowing of the escape of the vitiated, and admitting of the entrance of pure air.

It has been remarked that fireplaces and chimneys are meant to secure heat, windows light, and doors approach to our rooms; but that there is no provision for ventilation. Fortunately for us, this axiom, although well intended, is not true, as were it not for the doors and windows and chimneys, our breathing process would long since have ceased. The fact is, that the arrangements we have been obliged to make for heat, light, and access to our chambers, have hitherto, although lamely, supplied us with a make-shift ventilation, thus causing this important subject to be overlooked; and I regret to add, that I daily see modern houses constructed without proper attention to this matter; nay, the architects and builders are even quite alive to the necessity of ventilating the *materials* of which the house is built, but as to the occupiers, this does not enter into their philosophy. Witness the ventilating gratings to admit the air to the rafters, and louvres to admit it to the roof, whilst the smallest quantity of fresh air is religiously excluded from the human props of the house, and *that* where life depends upon a good supply of it. Before presuming to bring this subject under your notice, I may mention that I seized with avidity one of the most recent, and I believe popular, books on house architecture. It is a large octavo, filled with most elaborate drawings and plans, and containing no less than 484 pages of exuberant letter-press, of which *two* were devoted to the discussion of the sanitary arrangements!

Every occupied room, whether for rich or poor, young or old, sick or healthy, for man, animal, or plant, ought to have provision made for a constant atmospheric change; this is best done by an arrangement expressly directed to that object. For this purpose there should be two special openings—one always placed in the highest level of the chamber for the escape of the heated and vitiated air, the other in the most convenient part of the room for the admission of pure, which is usually colder, air. Both of these openings ought to communicate by means of closed chambers or tubes with the external atmosphere—*that* for the *admission* of air directly, *that* for the escape may pass into other chambers, such as a chimney or an unoccupied louvred attic; the direct communication is, however, far preferable where it can be accomplished. Arnott's very ingenious ventilator is adapted to the latter purpose, and is usually inserted into the chimney near the ceiling, upon the principle that the air in the chimney, being at a higher temperature, adds to the exhausting effects by drawing out the heated air in the elevated part of the rooms.

The different opinions held upon Arnott's ventilator have rendered it a species of paradox in the *science*, as it has proved a puzzle in the *practice* of ventilation—as, although it answers admirably in some cases, in others it does not act at all; or is even subject to a blow down, admitting smoke, and disfiguring the room. I believe the explanation to be this:—In those grates in which the draught is confined, or narrowed *below*, as in Sylvester's grates, the action of the ventilator *above* in the chimney is necessarily increased, consequently it acts with precision. On the contrary, in the ordinary registered grates, where the draught is much more open, the exhaustion of the air through the ventilator amounts to nothing, and even admits of a blow down occasionally. The down currents of cold air in the corners of our square chimneys may further explain the occasional failure of Arnott's ventilator.

The simplest manner of making the exit tube is by leaving a shaft in one of the walls communicating with the ceiling of every chamber in the house, and running up to the roof in the chimney stack. I have adopted this plan in some lodging houses which I lately built for the poorer classes; it is inexpensive, and answers the purpose very well. Miss Nightingale recommends a similar plan. The same object is easily accomplished in the bedrooms of the rich and dwelling rooms of the poor on the plan recommended by Dr. Collins, in a scheme for ventilation laid down by him in a paper read some years ago. He advised that wooden tubes should be run up in the angles of the walls, from the ceiling to the roof. Of course, the size of the tube may vary according to the number of occupants; for a room of twenty feet by fourteen, four inches square would answer. A blow down rarely occurs from this, if led to the roof at some distance; but if it should, a louvred adaptation must be made above, and a screen below if necessary. In case of larger tubes, when ventilation is required on a greater scale, as in hospitals and public buildings, the outlet above must be roofed and louvred, and even a traversing cap may be necessary to prevent down currents in changing winds. In the reception rooms, and particularly in the dining rooms of the better classes, where elegance is as well to be considered as health, the best and least objectionable plan for the exit tube is to place it over the gasalier, lustre, or lamp in the centre of the room. This plan I have adopted in my dining room; the fitting, which is inexpensive, was prepared by Mr. Daniel, of Mary-street. It fully exhausts a room of about twenty-eight by twenty feet, occupied by twenty-four people, and by eight No. 4 fish-tail gas burners, burning four cubic feet of gas per hour, with a pressure of seven-tenths. Having first removed the old solid centre piece, and procured a crenelated centre piece of two feet six inches in diameter, the ceiling was removed to the extent of two feet to admit of fitting two half-funnel-shaped vessels of zinc, such as I exhibit. These are, as you see, open below, and terminate above in two zinc tubes two inches by two each. These tubes run, one at either side of the rafter, underneath the floor of the drawing room, rising about one in thirty until they reach the wall. They then unite in one zinc tube equal to the diameter of both, which runs upwards behind the drawing room skirting, and penetrates the outside wall. It here passes upwards perpendicularly for about four feet, when it opens under an extinguisher-shaped roof raised about four inches from and projecting about two inches beyond the funnel. The gas, which is thus consumed immediately below the funnels, in place of loading the atmosphere with offensive matter, is of great value in securing the proper ventilation of the room. The air, heated by combustion, rises rapidly to the funnel, and rushes along it, effecting that which is most difficult to accomplish in all ventilation—the certain and speedy removal of the vitiated air from the room. I must endeavour, before leaving this branch of the subject, to impress upon you that the fire chimney is not to be relied upon for the exit of vitiated air. Daniels' experiment, in which he proved that the watery vapour emanating from eight people continued to charge the atmosphere until the point of condensation reached 52° from 39°, where the air escape was restricted to an open chimney, is conclusive upon this point.

To supply fresh air in place of that so removed, the simplest plan is to make a direct communication with the external atmosphere, but of somewhat larger dimensions than the exit tube, as the fire chimney also carries off a large supply of air from the room. *We* prefer taking our supply direct from the outer atmosphere. Many comfortably disposed people might prefer taking their supply from the heated air in the passages or other rooms of the house: were we satisfied that the air in the passages was not vitiated, the same objection would not hold to this plan. An instance of this faulty arrangement upon a large scale came under my notice some years since, when my friend Dr. Corrigan and I were directed to inquire into the cause of the mortality of the infants in the North Dublin Union Workhouse. We there found the infant day room occupied by some hundreds of children (to whom pure air was of the most vital importance), supplied by means of several borrowed communications, by the air that had already permeated the lungs of the occupants of the adult day room, and *vice versâ*.

It is, therefore, safer to admit the air direct into our sitting rooms, as well as our bed rooms—but, above all, to secure this being done into the dwelling rooms of the poor.

In my lodging houses I have adopted the plan of simply inserting two perforated bricks close to the ceiling, one on a level with the inner, the other with the outer surface of the wall, and with a communicating chamber. This secures double currents, so as to heat the stream of air on entering, and thus lessen the draught. It has further the advantage of being inexpensive, always in operation, and cannot be put out of order.

In my own dining room I prefer retaining the power of moderating the quantity of air admitted, according to the number of occupants, and I have two apertures of four inches by eight communicating directly with the outer air, but fitted with perforated zinc plates, which reduces the measurement to about 3½ by 3⅛—or, say eleven superficial inches each—with sliding doors so adapted that a greater or less supply can be admitted, or the supply altogether shut off. Where it is an object to render the supply uninterrupted, it is better, for several reasons, to place these apertures on a level with the ceiling, and this further secures a more complete circulation of air, and warms the air before impinging upon us. The cold air on entering the room, by its greater gravity, gradually approaches the floor, adopting certain curves, depending upon prevailing currents, and then, when heated, reascends. Thus a double circulation is secured. The having the apertures below certainly renders them more within reach for regulating them, although, on the other hand, it brings the air in its lowest state of temperature in contact with the person of the occupant, and particularly with the feet; whilst, for the purposes of health, it is rather an object to keep the feet warm, and the head cool. On the whole, then, I think it safer to open the supply air tubes on the high level, and to adapt a lever, so as to regulate them in that position; this adds but little to the expense. Where the contrary plan is adopted, the opening can be made behind the window curtains, and thus a more gradual diffusion with the heated air of the room secured. Mr. Louch, of this city, in his excellent pamphlet on ventilation, recommends a ventilator with several perforated zinc plates in place of the two above-mentioned, with a view to restrain the currents and heat the air on its entrance, taking the hint from the respirator. Mackinnell has constructed a ventilator of an outer and inner tube; the first admits the ingress, the latter the egress of the air.

Ventilators are sometimes attached to the windows. Cooke's ventilator is fixed to the top of the window, made of copper gauze, in two planes, placed at an angle of 45°; the heated air escapes at the upper plane, and the cold enters at the lower. Mr. Green, of this city, has invented one of a semicircular shape, which is stationary, and also of wire gauze. Cooke's moves with the window sash, and is only in operation when a portion of the window is open. Sherringham's ventilator is an ingenious contrivance, constructed with a view to prevent the blow down.

In default of ventilators, windows should be made to open from the top. When this cannot be done, the lower sash may be thrown up about three inches, and a piece of moveable board fitted into the interspace between the lower part of sash and frame. This secures a safer supply of air above between the sashes, which blows upwards, instead of blowing directly on the occupants.

VENTILATION OF CHURCHES AND PUBLIC BUILDINGS.

In a sanitary point of view, the subject of house ventilation would be quite incomplete, did we not draw attention to the necessity of improved ventilation in our churches and public assembly rooms, as whatever care we may adopt within our houses will prove inadequate to prevent the evils resulting to us from this neglect, unless *their* state be attended to also. These buildings, being required merely for temporary purposes, are never constructed with reference to the number of occupants crowded into them. Did we give 1000 cubic feet of atmospheric air to every occupant of a church, concert room, or aggregate meeting room, these rooms would assume an expansile extent totally impracticable. It the more behoves us, then, to provide in these for a rapid, constant, and certain change of atmosphere, in doing which we must recollect that each person in the church vitiates a gallon or three hundred cubic inches of air each minute he remains there. But do we find that a provision is made for this to be the case? Who that walks into one of our popular churches, with its closely packed crowd of human occupants, can fail to be struck with the stolid indifference pourtrayed in the listless, relaxed attitude and sleepy stupor of the mass of the congregation, despite the efforts of the pulpit orator, aided by a resounding voice and athletic arm, to arouse their consciousness? The fact is, that the congregation is much in the same state as if it were breathing in a charcoal-poisoned chamber, or under the influence of chloroform. The occupant, in addition to stupor, experiences a sensation of cold in his extremities from remora, or retarded circulation, and his inhaling carbonic acid gas instead of oxygen. Let the inquirer look up, and he will either find the ceiling without ventilators, or, as is not unfrequent, the ventilators carefully battened down with two-inch plank, lest a blow down should elicit a sneeze from the churchwarden or the sexton. Let him endeavour to look across the church, and he will find the atmosphere so charged, that he cannot recognise objects with which he is familiar at the usual distance; but, above all, let him look to the walls of the building, and if these have been coated, as they often are, with oil paint, he will detect trickling streams, running into small rivers, pervading them throughout, and often washing down upon the wall, seats, or floors of the galleries. What, let us ask ourselves, are these rivers? The human exhalations thrown off by the lungs and the cutaneous surfaces of the congregation, which have thus surcharged the atmosphere, and which, on coming in contact with the cold walls, have become condensed into the purling streams described. It is too offensive to contemplate the excrementitious accumulations resulting from the number of times each particle of air thus breathed must have traversed the lungs and impinged upon the skin of the various members of the congregation before becoming thus loaded. But this is not all; the congregation separate, and the windows are kept carefully closed to have the church comfortable for evening service; the congregation reassemble, the process recommenees—but, as the evening congregation is not generally so large, the deficiency of supply in the generation of animal exhalations is compensated by the evaporation from the walls, and so the supply goes on.

How is all this to be prevented? First, by securing a proper system of ventilation on the principle already insisted upon, only taking care that the supply and exhaustion of the atmosphere bear a proper relation to the number of the congregation, and that this be done without causing dangerous currents of cold air; and, secondly, as with every precaution that can be safely adopted, the likelihood is, the atmosphere will be loaded at the conclusion of each service, let the windows and doors of the church be one and all thrown open the moment the church is evacuated, and the fires kept alight for the whole of the Sunday, beginning at six o'clock in the morning, and keeping the windows and doors open until shortly before morning service commences. It is of much more importance to the congregation that the fires be lighted before and after, than during the service, in a sanitary point of view. In a public room merely occupied at intervals, it is better that the walls should be finished in distemper, or, better still, in lime wash, than in oils. In the former cases they act as an extensive sponge, absorbing the fluid exhalations, which, by proper ventilation and heating, should be dried out before its next occupation, and the poisonous carbonic acid permeates them, which it does not in the oil-painted walls; whereas in the latter the vapoury exhalations are immediately converted into fluid, and, when re-evaporated by the heat of the atmosphere, are reintroduced into the lungs of the occupants. In recommending distemper colouring, I should however advise that size and soap be omitted, merely using whiting or lime wash with tints of colour to please the eye, as the idea of inhaling the parasitic organisms generated in size or other animal matter is offensive.

Ventilation should, then, be freely introduced into churches and public buildings on the same principle as in our houses, both to secure the entrance and escape of the air. These, although combined with advantage with our heating apparatus, should not depend upon this, as in summer, when the air is stagnant, we do not use artificial heat; we shall, however, recur to this matter in connexion with heat; but I cannot close our observations on ventilation better than by reminding you of the important proof of its efficacy established by a fellow-citizen of yours, the late Dr. Joseph Clarke, who, by improvements introduced into the ventilation of the great Lying-in Hospital at the end of the last century, reduced the mortality amongst the infants born there from 1 in 6 to 1 in 104.

HEAT.

In all our sanitary arrangements, both within and without our homes, it becomes an object with us to maintain the human body at an equable temperature. This is done by elevating the temperature of the atmosphere in cold climates, and reducing it in warm climates, to a degree compatible with health and comfort, and by the adaptation of some artificial covering to the body that accomplishes the same objects without impeding our motions. This, then, brings us to the consideration of the means of heating and cooling our houses, and the best means of clothing ourselves. The first matter to bear in mind is the tendency in all substances coming in contact to equalize their temperature—that is, for bodies warmer to impart a sufficient amount of heat to colder bodies, or to bring both on a par. Some bodies do this more rapidly, others more slowly; the former are termed good conductors, the latter bad conductors of heat. Now, this is a distinction that we must never lose sight of in dealing with our present subject.

In cold or temperate climates, such as ours in the winter season, our energies are directed to elevating the temperature of the air within our houses; and, to do this effectually, we must isolate our house from the surrounding atmosphere. If this has not been sufficiently attended to in its erection, the difficulty is afterwards much increased, and often nearly insuperable. The selection of a porous subsoil in our building site, the thickness of the walls, the nature of the materials used in building, the placing the houses in an elevated situation, but with protection from prevailing winds, the avoiding too close proximity of trees that cause damp, the interposing a good mass of atmosphere between the ceiling and the roof, the having a basement story, and, above all, the having the carpentry of the windows and doors complete in its fittings, which can only be the case if seasoned timber is used in their construction—are all matters which, if not carefully attended to in the construction of the house, can rarely be afterwards remedied. We shall suppose that, as far as practicable, the above requirements have been carried into effect; still we must have communication with the external atmosphere, and even if we had none, the process of giving off heat through the walls, roof, and floor, would go on until an approximate equalization would occur between the air within and without the house. To elevate the temperature, we must therefore generate artificial heat within the house, and, as far as possible, prevent its abstraction. The generation of heat is produced by combustion, and our choice of combustible materials is limited to four—wood, peat, coal, and gas. Wood and peat are so rapidly consumed, that, except to those living in a forest or a turf bog, where labour is cheap and water and railroad carriage are unattainable, coal is the most economical fuel. It also possesses the advantage of eliminating a much larger amount of heat by the combustion of a given quantity, and of requiring a much longer time to consume. Gas, unless where heat is required only for temporary purposes and on a small scale, is not much used for the purpose of heating, because it is not considered an economical, although it is a very simple, speedy, and elegant way of generating heat for domestic purposes. For ordinary purposes, where a temporary heat is required, it is doubtful whether we are right in our idea of gas being more expensive. Soyer, who was a culinary contractor on a large scale, used it for the purposes of cookery.

GRATES AND STOVES.

In Britain, where coal is plenty, we adhere generally to the primitive system of burning our fuel in open fireplaces, with chimneys to carry off the smoke or unconsumed carbon. On the Continent, where fuel is scarce, and wood or charcoal in more general use, the stove is more common. There can be no question that of these two the open fireplace is the more wholesome, and safer to the inhabitants of the house; because, while the unconsumed products of combustion are removed, the air in the apartment is not burned by contact with the metal; and, second, because the process of ventilation, which is seldom otherwise provided for, is best secured by an open chimney. On the other hand, however, there is a much greater loss of caloric in the open chimney, and consequently a greater consumption of fuel in obtaining the same elevation of temperature. Much has been done in our improved kitchen ranges to meet this objection and economize the caloric, by making the same fire perform several culinary operations at the same moment. A certain amount of fallacy exists in carrying this principle out to extremes; as, however we may economize the caloric developed and direct it into ingeniously devised chambers, imparting heat to articles of food contained in each, it is a self-evident fact that every particle of caloric imparted must be rendered by the fuel submitted to combustion, and of course fuel must be consumed in a direct ratio to the heat imparted. In other words, in a kitchen range performing a number of operations, coal must be heaped on in proportion to that number.

It should be recollected that heat radiates in every direction, consequently the grate should be elevated sufficiently from the hearth to give to the chamber the benefit of its radiations *downwards*. It is also to be so constructed as to give the effect of its lateral radiation, and, if possible, its radiation backwards and upwards should be preserved.

Now, in our ordinary grates these points are completely lost sight of, the consequence of which is, that we generally lose all the radiation upwards and backwards, and retain little or none of the heat radiated downwards and laterally, obtaining merely the radiation forwards. In the construction of our flues, to secure a proper amount of exhaustion, as extremes are pernicious, the smoke tube or chimney should be of proper form. The higher, of course, the greater draught, but its form is also a matter of consideration; hitherto it has been square, but the practice latterly has been to construct chimneys of a cylindrical shape to lessen the accumulation of soot, and because smoke in the mass assumes a cylindrical form. Now, although the volume of ascending smoke has a tendency to assume this form in its issue from the square chimneys, it must be recollected that the corners of square chimneys admit of enough of downward current to facilitate the upward circulation. In calculating the diameter, it should be borne in mind that a cylinder of twelve inches diameter is only equal to a square of nine. These considerations may explain why earthenware cylindrical chimneys become so sensitive and liable to blow down on changes in the force of the wind. Another principle that should not be lost sight of is this, the relation that ought to exist between the point of access of the air at the fire and the outlet at the top of the chimney. The latter should exceed the former by about one-third.

The approximation of the fuel under combustion to the entrance of the chimney influences the draught greatly. Combustion can only be sustained by the contact of atmospheric air; and where it is an object to increase this, we must recollect that at the posterior part of our fires little or no combustion exists. To meet this difficulty, perforated metallic backs have been placed to grates. But if there be no radiation backwards, this additional consumption of coal is lost, as the caloric disengaged behind will in all likelihood radiate upwards to the chimney.

Having premised that the objects to be desired in selecting grates are, complete combustion, large radiation into our chambers, certain draught, ventilation, and facility of approach to the flue, we shall best explain how these objects are to be accomplished by exhibiting a few grates in which these points have been more or less completely carried out, dwelling upon the merits and demerits of each as we proceed. It must be borne in mind that the more of these requirements a grate possesses, the more perfect it is. Sylvester's grate possesses hearth, plate, and supply tubes. It is splayed with polished metallic planes, but the communication between the flue and grate is too narrow. It radiates a large amount of the heat generated, and this raises the temperature of the room very high, yet it renders the atmosphere stagnant, and is consequently a bad ventilator.

Stevens' patent—a grate half circular in its form, and with a flat steel ashpan; it radiates largely, and has an increased draught, and is therefore a very good grate.

Bashford's disc—the form and reflecting power of this grate are such that it radiates the greatest amount of heat—indeed, some might imagine too much. It is particularly suited on this account to the end of a long room where there is but one fireplace. The objection as to ventilation is got over by a more open communication with the flue. But the draught in it is very great, like Sylvester's grate, from the approximation of the flue to the fire. This difficulty is compensated for, however, by having its front moveable on rollers and hinges, so that ventilation can be amply secured, or the grate cleaned, by drawing the patent front out.

Wright's bivalve is the nearest thing to perfection in outline and action, and radiates admirably. Its ventilation, however, is not so perfect, although this also is improved by the introduction of a second valve to lessen the intensity of the draught. The objections to Stevens' patent have been obviated in this grate by enlarging the valves and rendering the front moveable, as in Bashford's disc grate, in order to afford the power of cleaning and increasing ventilation.

King's patent possesses the greatest advantage of any grate yet constructed of retaining the heat in the chamber, its construction preventing the escape of the slightest quantity of the atmosphere, unless that occupied in securing combustion. It, however, possesses the greatest disadvantage in ventilation, and is little better than an inverted stove. It may here be mentioned that Arnott's ventilator, by its action or failure, is not a bad test of the ventilating powers of a grate.

On lighting a fire or stove in the hall or central passage of a house on the ground floor, the heated atmosphere rises, and pervades every passage and room in the house, rendering unnecessary large fires in the rooms, because the air in the passage does not abstract their heat. It maintains, consequently, an equable temperature through the house. Much has lately been said about keeping the windows of our bedrooms open at night, winter and summer. This may be done in summer, taking care to screen the direct draught of air from the part of the room occupied; but in the winter it can seldom be done with impunity in this climate.

It should be recollected that the top rooms are the coldest in winter, and the hottest in summer, from the more rapid radiation of heat in the former, and the more rapid and direct absorption of heat in the latter. This is always more markedly the case when the mere rendered roof forms part of the ceiling without any intervening air chamber, and when the roof is covered with dark-coloured slates. When inconvenience arises from cold in attics, they are rendered much warmer by a counter or false ceiling enclosing an inter-space of atmospheric air, which is a bad conductor.

The ventilation of our churches and public buildings is usually combined with a different plan of procuring heat from that in our houses. Latterly stoves have been substituted for open fireplaces, which deprives us of the assistance they rendered as an additional means of ventilation. The ordinary stove for churches with descending flues is so arranged to prevent the unsightly appearance of a funnel running up the centre of the church. This is a species of furnace which merely admits air enough to secure the combustion of the fuel, and the draught is obtained by exhausting the air in the chimney by means of a second fire in a separate chamber placed on a lower level.

Of late years the practice of heating churches, public buildings, and mansions, has been much carried out by first elevating the temperature of water or air, and then conducting this heated fluid through the house, which, on its passage, imparts caloric to the atmosphere. There are various plans in operation to effect this purpose; their promoters insisting upon the more certain, the more equable, and some even have it the more economical, diffusion of heat secured by them. Heated air has long been in use in our hothouses; but in them, as in our dwellings, the objection of burning or drying the atmosphere has been so proverbial, that the evaporation of water artificially to re-supply the moisture of the atmosphere is practically necessary. Warm water heating is not liable to this objection to the same extent; but those who have frequented houses thus heated are rarely so satisfied with the atmosphere as with that heated by open fireplaces. Besides, the tendency in most of these secondary plans of heating is to elevate the temperature too much—a circumstance injurious to the health of the occupants, as rendering them more liable to the deleterious effects of sudden exposure to a reduced temperature. The effect of stepping out of these houses is much the same as that experienced by our imprudent countrymen, who dally ont of doors in the South of France at the moment of the sun's sinking below the horizon. Another plan still is occasionally adopted for heating—namely, rendering the chamber heated a portion of a flue or chimney, no air being allowed into the chamber which has not traversed a heated air chamber, or passed over the surface of heated iron plates. I here exhibit diagrams of Perkins' plan for heating and ventilating the Justiciary Court, Edinburgh, and of Cardell's warming and ventilating arrangement for bookbinders' rooms; also of the Belpar stove for generating a large amount of heat, kindly furnished me by Professor Shaw, of Trinity College, and shall subjoin his table, slightly modified, on

Smoky Chimneys.

CAUSES.	REMEDIES.
1. Want of air for fire.	Diminish lower orifice of chimney; increase the supply of air.
2. Fireplace too large.	Diminish at the sides, and above.
3. Chimney too short.	Raise up and contract the fireplace.
4. Interfering fires.	Supply air enough to each apartment, and detach.
5. Flues common to different apartments.	Guiding plate in flue, and traps for empty fireplaces.
6. Action of sun and wind, &c.	Adapt suitable screen, pots, and hoods.

The exhaustion of the heated air may be secured by a gasalier communicating with the roof, as we find in the Bethesda Chapel; or the fire may be placed in a distinct chimney, as was done by my friend the late Dr. David Boswell Reade in the Houses of Parliament. The currents of air in rooms still require much elucidation, and may be described as direct, retrograde, and irregularly circular in a chamber heated with one fireplace, and a ventilator over the chimney and window. Dr. Mapother gives the diagram I now exhibit, showing the circular transit of a gas balloon floating loose in an atmosphere of equal specific gravity. I cannot refer to this gentleman's lectures on public health, delivered at the College of Surgeons, without expressing my strong sense of the talent and information they display, and recommending them to your perusal.

CLOTHES.

Our subject would be incomplete, did we not consider briefly the means of sustaining the temperature of the body without our houses, and make a few observations about clothes. There is nothing upon which greater misapprehension exists in the popular mind. Clothes do not, as we imagine, convey heat; they merely prevent the abstraction of our internally generated heat, or perform the same office for us that the walls and roof of a house do. The human body possesses a power of generating heat through a process in some respects resembling combustion, and of retaining the temperature at about 98° of heat, whether the thermometer stands at zero or at 120 without the body. This regulating power we explain, as we do many other phenomena beyond our reach, by the use of a convertible term, and call it vital. By this vital heat-generating power, however, the human body is not removed from the influence of general physical laws when carried to extremes or long continued. And it is quite possible to roast and freeze it, despite the vital laws alluded to. It is equally possible, without proceeding to these lengths, to produce influences upon it through the application of heat, and by the want of heat, that prove highly injurious to its healthy functions. To prevent these injurious effects, clothes are worn; and strange as it may appear, clothes are used equally in cold climates to retain the natural heat, and in warm climates to isolate the body from the surrounding highly elevated atmosphere and the burning rays of the tropical sun. The old lady with her wrap of shawls and fur-lined hood, wending her way to her whist party in St. Petersburgh, on a December night, has a strange counterpart in the gallant young European officer, mounted on his Arab, with his head enveloped in turbaned shawls six inches deep, traversing the plains of Hindostan under a burning sun in the month of June; yet both are practical philosophers, despite the blow-hot, blow-cold objection. The experienced Russian matron is resisting a rheumatic attack by interposing a bad conductor between her head and the freezing atmosphere without, and thus preventing abstraction of her internal heat. The gallant Anglo-Indian is warding off a sun-stroke by interposing a bad conductor between his head and the scorching atmosphere and burning rays of the sun without.

In selecting clothes for a cold climate, then, as for a hot one, we approve of them in an inverse ratio to their conducting powers, and may place the textures generally used in the following order:—*Wool, Cotton, Silk, Linen.* In addition to the fact of its worse conducting powers, wool, by the friction it produces, assists in keeping up the temperature. This points it out as particularly suitable for cold climates; again, its powers of absorption, and, when charged with moisture, its worse conducting powers, causing it to abstract less heat, contrary to what is the case in a marked degree with linen, and in a lesser degree with cotton and silk, render it equally the most suitable texture in tropical climates. Woollen textures hold a larger quantity of atmospheric air within their meshes, which further adds to their non-conducting agency. The form or shape of our clothes is also a matter of some importance. We have already mentioned that atmospheric air is a bad conductor of heat; consequently, when our clothes are made loose and flowing, a quantity of atmospheric air is enclosed between the clothes and the person. This assists the clothes in preventing the abstraction of heat, rendering loosely fitting garments warmer in cold climates, and cooler in hot climates. These loosely fitting garments our police, as well as our military authorities, have wisely adopted.

It is a great mistake with parents to fancy that they serve their children by insufficiently clothing them, in order to make them hardy, in climates requiring the extremes of heat and cold to be moderated. The idea is unnatural—it is unphilosophical, and the practice is mischievous. Boys, whilst they take plenty of active exercise in the open air, may escape when lightly clad in very cold weather, because increased heat is generated by their exertions; but the moment they become passive, they are in the position of a hothouse plant, suddenly placed in the open air with the frost on the ground.

Felt, which is a very close texture, produced by the interlacing of the covering of certain animals, due to a serrated provision which it possesses, but which is not visible to the naked eye, is a valuable addition to our clothing, and ranks with wool as a non-conductor. It is not pliant, however, and consequently is reserved for clothing those parts of the body in which pliancy is not so much an object as resistance and impermeability; this explains its adoption in our hats, as well as back or neck clothing in warm climates, where there is much exposure to the sun's rays.

The present form of our hats I confess myself at a loss to account for upon any principle of reason, philosophy, or elegance! But, as the tendency is to ventilate them, we may possibly arrive at some explanation of it!

The colour of our clothes is so far a matter of consideration, that light colours possess the property of reflecting the sun's rays, whereas dark colours absorb them. The former, therefore, are more suitable to summer and to tropical climates, and the latter to our winter and cold climates. We shall not dwell upon the refinements of selection of colour, as fashion and taste will scarcely tarry for our guidance in such matters.

Although obliged to place linen as the best conductor, I should be sorry to be supposed so unpatriotic as to condemn its use : as an article for outer or intermediate clothing, our objection does not hold; and for summer wear and durability, no texture can exceed it in usefulness, as, from the perfection to which it is daily arriving, it may eventually excel cotton fabrics in beauty. Here are some specimens of Irish linen that bid fair to supersede cotton.

The first step was getting the mill-spun linen yarns, which rendered it more even, and better colour; consequently, required less time for bleaching, and gave more rapid return for capital. Power looms are now being introduced, which render the linens less expensive. They are now as cheap as the French printed cotton fabrics, and wear infinitely longer.

RESULTS OF ATTENTION TO SANITARY IMPROVEMENTS.

But it will be asked, what have you gained by attention to these sanitary improvements insisted upon? It is with no small pride I can answer that, without referring to Howard's opinion of the Dublin prisons, I can point to instances of progress in this direction in our own city when matters were at a low ebb elsewhere. I have already drawn your attention to the fact of Dr. Clarke's reduction of the infant mortality in the Lying-in Hospital from 1 in 6 to 1 in 104, 19-20ths of whom died from infantile convulsions. I have now to add that, by Dr. Collins's improvements in ventilation, this mortality was still further reduced to 1 in 666. This astonishing saving of human life, amounting to upwards of 600 per cent., was promulgated in Dr. Collins's admirable paper "On the Prevention of Contagious Diseases in the Homes of the Poor," read from the Chair of the College of Physicians in February, 1848. Another instance was the reduced mortality in the Protestant Orphan Society of Dublin, which since the orphans were boarded in the county of Wicklow only amounts to one per cent. I need only contrast this with the mortality of the pauper infants of the London workhouses in the last century, who died at the rate of twenty-three out of twenty-four within their first year. I shall not do more than refer to the tables furnished by us of the mortality of the foundlings of this city at a much later period, as it is unpleasant ripping up a reminiscence so disgraceful to our common humanity. Looking at these results, and many others that I could adduce did time permit, do the opinions of those who affirm that man's average age, under proper management should approach to eighty, seem so preposterous? Do the results of our exertions hitherto justify our persistence in the efforts recommended? I answer—the average life of man in England, or death age, as it is termed, is now forty-six; that, honour to the exertions of the late Lord Herbert and Lord Shaftesbury, the death rate in the British army at home, which averaged 17·5 in 1000, is decreased to 8½; whilst at Aldershott and Shorncliffe, through the exertions of Miss Nightingale and others, it has fallen to 4·7 in 1000. The improvement in the sanitary condition of the barracks by ventilation and otherwise, gave the following results in the death rate of the different branches of the service:—

Average of ten Years.

	1837.	1840.	In	1850.
Infantry Regiments, ...	17,	9,	To	7·6 in 4000
Foot Guards, ...	20,	4,	,,	9·1 ,,
Royal Artillery, ...	13,	9,	,,	8·0 ,,
Dragoon Regiments, ...	13,	6,	,,	8·0 ,,

It should be mentioned that 1000 cubic feet of atmosphere form now the minimum allowance in the military hospitals.

The same Divine authority that asks, "What man is he that liveth and shall not see death?" hath also said, "The days of our years are threescore years and ten." This at least should constitute our standard to aim at for every other man, as most of us calculate upon it, however unwittingly, for ourselves.

It now only remains to say one word in apology for this paper.

Without assumption, I might claim the power of being able to display more learning in it, had that been my object. I might have grappled with the cloaca-maniaists (from whom, I honestly admit, I have begged the question), and rendered it even sensational, had I so desired. But the task I pointed out to myself was more practical—namely, to enunciate in language intelligible to every householder those neglects in the every-day management of our homes and families with which my opportunities had long rendered me but too familiar. I now hand it over to your tender mercies, and doubt not, from the time occupied in its discussion, there are many sages amongst my hearers ready to apply the language of the poet:—

"'All this is madness!' cries a sober sage.

But who, my friend, has reason in his rage?

The ruling passion, be it what it will,
The ruling passion conquers reason still.

"Less mad the wildest whimsy we can frame,
Than even that passion, if it has no aim;
For, though such motives folly you may call,
The folly's greater to have none at all."

III.—On Arctic Discovery. By John Locke, A. B., &c.

[Read before the Royal Dublin Society, March 20, 1865.]

Captain Sherard Osborn has suggested the project of another expedition to reach the North Pole by Smith's Sound; and Dr. Petermann, of Gotha, a veteran author on this frequently-discussed topic (having published at different times fifteen treatises on polar discovery), has addressed two letters to Sir Roderick Murchison, President of the Royal Geographical Society, advocating in preference the route by Spitzbergen, and asserting that the sea is open in winter by this course to the Arctic Pole. These communications have been sent in lithograph to a few correspondents; the first Paper on Arctic Discovery has been already discussed at a meeting of the Geographical Society; the second, reviewing the comparative progress of Antarctic research, has not yet been made public; but I may observe, that the subject was brought before this Society in November, 1860, in a Paper communicated by me on Maury's curious theory of the existence of a habitable and temperate region enclosed within the icy cincture of the Antarctic zone.

In reading the adventurous expeditions of the voyagers and whalers of the sixteenth and seventeenth centuries, in their small and ill-found vessels, sometimes not exceeding fifty or sixty tons, one is inclined to believe that the Arctic polar space has been repeatedly sailed over by these enterprising navigators. But, to come to the present century, we find the remarkable fact of a Polynia, or permanently open Arctic sea, clearly established by the researches of English, American, and Russian explorers. Parry, in 1827, starting from the northern shore of Spitzbergen, by sledge and boat, reached the latitude of 82° 40′, in view of an ocean entirely free from ice, and which would have stopped his advance, even if the floes had not been drifting southward more rapidly than his sledge travelled in the direction of the Pole. Again, Kane, in his sledge expedition along the western shore of Greenland, asserts that he reached in latitude 82° an open sea of a temperature of 36°, with innumerable birds and seals sporting on its surface; and Wrangell, in his sledge journeys from sundry points on the coasts of Siberia and of the Lachow Islands, invariably reached an ocean entirely free from ice at from thirty to forty miles from land:—"We beheld (he says) the wide immeasurable ocean spread before our gaze; a fearful and magnificent, but to us a melancholy spectacle." Melancholy, because that very ocean was an insuperable obstacle, as in Parry's case, to his advance northward by sledge. There is a vast fund of information on Arctic exploration by Russian enterprise accessible only to the few who are acquainted with the Russian language. Wrangell's narrative has become known to English readers through Mrs. Sabine's translation from the German edition; and a joint enterprise, organized by England and Russia, might prove the most likely to accomplish results conducive alike to the progress of commerce and science. It would assuredly be wiser for both Powers to shake hands within the Polar circle (cold comfort!) than to meet in arms upon the sweltering sands of Central Asia (hot work!) Now, in this view of the question, and admitting Petermann's suggestion of the Spitzbergen route, I venture to submit that that island itself, and not a distant British seaport, should be made the starting point for the proposed expedition, despatching from England for the required purpose an iron steamer of light draught, together with all the materiel of residence and comforts, which the commercial resources and mechanical appliances of England can so efficiently supply. Government support is not likely to be again conceded to Polar enterprises, except perhaps in the form of a small subsidy, or loan; but if a trading settlement in the Spitzbergen Archipelago is demonstrated to be feasible and lucrative, science will follow, as elsewhere throughout the world, in the wake of commerce. And what are the facilities and encouragements offered in this remote region to the trader and occasional settler? The largest of the islands is about the size of Ireland; the Gulf Stream there reaches its northern limit, and loses itself within the intricacies of the Archipelago, which is manifestly the cause of the Spitzbergen winter being milder than the winter temperature of Nova Zembla, and parts of inhabited Greenland, North America, and even Siberia, all situate in more southern latitudes. Professor Scott will exhibit Dove's maps, illustrating this curious fact by the isothermal curves. Again, the ocean temperature off the Spitzbergen coast, as tested by the deep-sea thermometers, is but one degree colder than at the same depths in the Carribean Sea, the heavier and colder current returning southward along eastern, or "lost Greenland," as it is expressively termed; for that region possessed many colonies of Norwegian and Icelandic refugees and adventurers, who had settled there so early as the ninth and tenth centuries, but of whom now scarcely a trace exists, except the ruins of their habitations, which seem to have been overwhelmed by inundations from the bursting of glaciers. The Gulf Stream must have at a former period flowed along this coast; for Hudson, in 1607, writes:—"We ran along near the shore, and found no great cold, which made us think that if we had been on shore the place is temperate." But since Hudson's visit East Greenland has been shut out from the navigator by fixed ice floes of hundred of miles in extent; and our chief knowledge of "lost Greenland"* is now derived from the land expeditions of a few travellers, especially of the Danish explorer, Sir Charles L. Giésecké, who was Professor of Mineralogy to the Royal Dublin Society some forty years ago, and communicated a Paper to the Royal Irish Academy on the subject in 1824. A complete history of his Greenland researches is extant in manuscript in the University Library at Copenhagen, and which Mr. Scott, our acting Professor of Mineralogy, expects to obtain and translate into English. Giésecké's curious and valuable collection of Greenland minerals in our Museum have been accurately classified and arranged by the Rev. Professor Haughton, and are supposed to be analogous to the characteristic mineralogy of the Spitzbergen Islands,* in which are found various ores, and, what is even more important for the settler and trader, beds of bituminous coal. Drift-wood also is borne to the shores in great quantity by the Gulf Stream; and the wood hills (described by Wrangell in Kotelnoi) consisting of interstratified sandstone and trunks of resinous trees, are stated to be found. However, even if delay occurred in procuring sufficient fuel on the first organization of a settlement, the marine and mineral oils (the latter of which are gradually coming into economic use both for heat and light, and motive power on sea and land) would amply and cheaply suffice for the brief interval. Fossil ivory is not so plentiful in Spitzbergen as in Northern Siberia and the Lachow Islands, where in many spots the soil is actually composed of masses of bones of the Mammoth and other extinct Mammals, bound together by frozen silt and mould. These immense deposits of fossil *reliquiæ* in certain detached localities is one of the strangest of geological puzzles. It is exemplified even in Ireland by the great number of skeletons of the *Cervus megaceros* found in particular spots in bogs, or in the lacustrine marl. Dr. Carte, in a Paper read before the late meeting of the Geological Society of Dublin, states that in one circumscribed spot of little more than half a mile in length on the River Commogue, in the county of Limerick, horns and other portions of forty skeletons have been dug out within the last few years; and the peasantry, who sound the marshy soil for these with long iron rods, the bone or palmated horn returning a dull and peculiar sound, expect to exhume many more antlers and bones in the same locality.

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* There are dim Scandinavian traditions of the existence of a circumpolar Arctic land, still inhabited by a lost people, severed from the rest of the world, although no traces of any similar tradition have been noted among the natives of the southern hemisphere; yet, if Maury's ingenious meteorological inferences are ever found capable of verification, the inter-antarctic spaces would be more likely to attract the refugee or castaway to abide within their comparatively milder temperature.

But—to return from this digression—the first principal resources of Spitzbergen trade would probably consist in Narwhal ivory, the marine oils, and the peltry trade. The Arctic Bear and White Fox are numerous, also the Reindeer, which remain throughout the year, the vast distance from other lands, either insular or continental, and the intervention of seas never completely bridged by ice, preventing migration. The waters teem with fish, and with the Cetacea and Seal tribes. —— Parry found the vegetation rich and plentiful in Hecla's Cove and other localities; and, besides the nutritive mosses and other crytpogamous plants both of land and sea, ninety-three phanerogamous species were observed.

Among the multitudinous varieties of birds, the Northern Grouse (*Lagopus hyperboreus*) the Ring Plover, Auks, Guillemots, Puffins, the graceful Eider Duck, and Bernacle Goose, with others of their kindred tribes abound. Richardson's Skua sweeps with ample wing through the snow storm; and the notes of the beautiful Snow Bunting (*Emberiza nivalis*), the only song-bird of Spitzbergen, enliven the dreariness of the misty ravines and frozen plains. Several of these species furnish large resources of agreeable and wholesome food, easy of preservation for any length of time in that climate; and the uncommon beauty, graceful movements, and varied habits of the innumerable seafowl, give to these inhospitable solitudes a cheerful life, and continual opportunities of observation and amusement, which the Arctic traveller only can understand and appreciate.

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* The precious garnet is the only gem observed in the Spitzbergen islands; but the mineralogy and geology are as yet little known.

These few remarks, I trust, are sufficient to prove the feasibility of a permanent settlement on these islands, even within the Arctic circle, and to prove that a continued residence is consistent with the preservation of life and health: a confirmatory fact adduced by Petermann in a former treatise may be added—that Mr. Crowe, then British Consul at Hammerfest, testified that a Russian, named Gharastin, had resided in Spitzbergen for fifteen consecutive years. The Russian hunters also, who sometimes remain during the winter months, describe the weather as milder than in parts of the Siberian mainland.

In adverting to the plentiful supply of carbonaceous food, so necessary to support the fire of life in regions of extreme cold, Professor Owen conjectures that the Manatee may be found in the Spitzbergen waters, and identifies this strange creature, the most like man in appearance and functions of all marine animals, with the mermaid of Norwegian story; but I venture to think that another of the herbivorous Cetacea, the *Rytina stelleri*, which has been totally exterminated by the voracity of the whalers and Esquimaux in Behring's Straits, is much more likely to be met with than the Manatee, a creature hitherto found only in tropical waters. The flesh of both animals is described as tender, and of a delicious flavour, like pork or veal.

Some members present may remember a Captain Semmes about thirty years since, of whom Alexander V. Humboldt makes a sad complaint (recorded in the "Kosmos," vol. i., p. 161), that he worried him and Sir Humphrey Davy to join in undertaking a subterranean expedition to the centre of the earth, maintaining that in or about lat. 82 deg. there was an enormous opening, from which issued the Auroral lights, and through which a descent into the hollow sphere could be easily accomplished. It is not intended to insinuate that scientific gentlemen of our day entertain such extravagant ideas, though they will naturally be enthusiastic, each in his special department, in the anticipation of curious discoveries in a region hitherto unexplored by man.* Mere scientific researches, however, will not induce a great mercantile people to risk further loss of life and treasure. In England commerce has been from the earliest period of maritime discovery the pioneer of knowledge; and I repeat, that the most practical method of insuring success is the establishment of a trading settlement within the limit of the Arctic circle itself. If such a settlement be found practicable, and consistent with the sustentation of life and health, and if the fact is satisfactorily confirmed of an iceless and open Arctic Ocean, of comparatively mild temperature throughout the year, Spitzbergen appears to offer a suitable starting point and secure platform to plant the lever of discovery, in endeavouring to reach the North Pole.

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* It is curious, that in Spitzbergen the mean declination of the needle from the geographical meridian has not undergone any sensible variation for the last one hundred years.

IV.—BOTANICAL NOTES IN THE MIDLAND COUNTIES. By F. J. FOOT, M. A., F. R. G. S. I.

[Read before the Natural History Society of Dublin, December 2, 1864.]

THE great central plain of Ireland, although generally monotonous from its flatness, and affording but few attractions to the lover of fine scenery, is by no means devoid of interest to the botanist. And yet how many a one, bent on a summer's ramble through the wilds of Kerry, Cork, or Connemara, flies by rail through the uninviting plain, only longing to reach his destination, without knowing that he is passing by many interesting plants! Although no actually rare plants occur, yet some are occasionally met with, which one would hardly expect to find, several of them being by no means common, or at least very local in their distribution. The River Shannon and its tributaries, which drain the plain, form a great natural mode of conveyance for transporting the seeds and spores of plants from one locality to another over a very considerable area. The plain is chiefly composed of the carboniferous limestone, from beneath which the older rocks occasionally rise, forming hills, which, though seldom attaining 1000 feet in height, are conspicuous features, relieving the general monotony of the landscape, besides affording for plants a change of soil and habitat. Having been engaged for the last three years on my survey duty in the respective districts around Mullingar, Athlone, Ballinasloe, and Longford, I venture to present to your notice a list of some of the more remarkable plants that I met with. The counties, or parts of counties, which I have examined are—East Galway, King's County, Westmeath, Longford, and Roscommon, and are in provinces 24, 25, 27, proposed by Professor Babington as convenient and natural divisions of the country for botanical purposes, in a paper read before the Dublin University Zoological and Botanical Association, February 18, 1859.* I shall mention the plants in the succession of their Natural Orders.

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* "Hints towards a Cybele Hibernica," in "Natural History Review and Quarterly Journal of Science" for October, 1859, p. 553; also, "Proceedings of the Dublin University Zoological and Botanical Association," vol. i., p. 246.

PHANEROGAMIA.

Thalictrum minus.—This pretty little, and decidedly local, plant grows in great abundance among the shingle, and in the crevices of the limestone rocks on the shores of Lough Ree, in the counties of Longford, Roscommon, and Westmeath.

Thalictrum flavum.—This is another plant of local occurrence, though generally abundant in its respective habitats. It grows plentifully in meadows in the county of Longford, on the banks of the River Inny, one of the main tributaries of the Shannon.

Chelidonium majus is to be met with in many places on shady walls in the midland counties. It is very plentiful in Westmeath, Roscommon, and Longford.

Drosera rotundifolia.—Abundant in all the bogs.

D. Anglica—*D. longifolia.*—I met these two species growing in great abundance along with *D. rotundifolia* at Cloghan Lough (county of Roscommon)—a pool in the bog on the east side of the River Suck, two miles E. S. E. of Ballygar (county of Galway).

Saponaria officinalis.—This beautiful and local plant I have only met with in two localities, viz., on a wall near Cloondara, and at Moydow, county of Longford; in both localities it flowers double.

Arenaria trinervis.—On a roadside in the neighbourhood of Athlone, county of Westmeath, but in no great abundance.

Euonymus Europæus.—The Spindle Tree grows plentifully on limestone crags on the shores of Lough Ree, in Westmeath, Roscommon, and Longford. I never saw it more abundant than at Rathcline, county of Longford, where early in October its beautiful and peculiar crimson berries contrast pleasingly with the surrounding autumnal tints.

Prunus padus.—Sparingly on the banks of the Suck, near Ballinasloe. In Ireland this plant is chiefly recorded from the north.

Geum rivale.—Occasionally to be met with, but in no great abundance, in crevices of the limestone rock on the shores of Lough Ree; also on the roadside near Glassan, county of Westmeath.

Rubus idæus.—Frequent in woods along the shores of Lough Ree and Lough Ennel, county of Westmeath.

R. saxatilis.—This beautiful bramble grows in the greatest abundance on the shingle and on crags on the shores of Lough Ree, in the counties of Westmeath, Longford, and Roscommon; very abundant at Rathcline and Cashel, county of Longford, where the limestone forms rocky hills, clothed in places with natural wood; also plentiful on the shingly shores of Lough Ennel, county of Westmeath, at Belvidere.

Rubus fruticosus.—I have not gone into the several varieties (or sub-species) of this very variable species; but probably most, or at least many of them, occur in suitable localities in the midland counties.

Sedum telephium.—I found this rather uncommon plant growing sparingly on Carberry Island, Lough Ree, near Athlone; also on an old road near Ballinalee, county of Longford.

Ægopodium podagraria.—On the roadside at Glassan, county of Westmeath. This umbellifer, though very abundant in the north, is not much known in the south or midland counties.

Viburnum opulus.—The Guelder Rose is very plentiful in shady woods and hedges, and on wooded crags, all through the midland counties.

Galium boreale.—This very local plant grows in rank luxuriance among the shingle on the shores of Lough Ree, in the counties of Westmeath, Longford, and Roscommon, associated with *Rubus saxatilis* and *Thalictrum minus*, the three giving a thoroughly natural stamp to the Flora of the place. It also grows sparingly at Lough Gara, county of Roscommon.

Tanacetum vulgare.—Near Ballymore and Mullingar, county of Westmeath; also sparingly in the neighbourhood of Longford.

Pyrethrum parthenium.—Sparingly in the neighbourhood of Longford. Besides these I did not meet with any of the rarer Compositæ. *Senecio jacobæa* varies considerably according to situation; and *Senecio viscosus* is not uncommon on the edges of bogs.

Digitalis purpurea.—On other occasions I have alluded to the occurrence of Digitalis in limestone districts. It grows abundantly all through the midland counties. A pure limestone soil is unfavourable to its welfare, but it prospers well on impure cherty and earthy limestone; in fact, a certain percentage of lime does not injure it.* I have observed that *Blechnum spicant*, also avoiding pure limestone, is frequently a cohabitant of Digitalis. A pure limestone soil is not more deleterious to Digitalis than it is to the Ericaceæ and several Ferns.

Scutellaria galericulata.—Tolerably abundant in woody places on the shores of Lough Erne, county of Westmeath.

Utricularia vulgaris.—In watery ditches near Castlepollard, county of Westmeath; it is an excellent plant for an aquarium, being both ornamental and easily grown.

Lysimachium vulgare.—Not common. It occurs on the south-east shore of Lough Ennel, and also in meadows on the banks of the Inny, associated with *Thalictrum flavum;* also at Lough Key, county of Roscommon.

Polygonum bistorta.—I met with this rather rare plant growing pretty freely on the banks of the Suck, near Ballinasloe, in the same place as *Prunus padus* above mentioned.

Salix pentandra.—The Bay-leaved Willow, perhaps the most beautiful of the Amentaceæ, is not uncommon along the banks of the Suck, near Ballinasloe.

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* Benbulben and the mountains about Glencar, near Sligo, are good instances of this. They are composed of dark grey or black earthy limestone, with bands of shale and nodules of chert, and occasional beds of purer limestone. Digitalis grows all over them in the greatest abundance.

Orchis morio.—The green-winged Meadow Orchis grows in great plenty, generally on the eskers in the counties of Roscommon and Galway, in the neighbourhood of Athlone and Ballinasloe.

Orchis mascula, O. pyramidalis, O. maculata, Gymnadenia conopsea, are all plentifully distributed through the midland counties in suitable localities.

Habenaria bifolia and *H. clorantha* are rather local plants. They are plentiful on the southern shores of Lough Ennel, county of Westmeath.

Habenaria viridis is generally distributed through the midland counties.

Ophrys apifera.—I was fortunate enough to meet with the Bee Orchis growing rather sparingly on the south-east shore of Lough Ennel. I have not heard hitherto of its being recorded so far inland.

Hydrocharis morsus-ranæ.—Plentiful in watery ditches about Mullingar.

Anacharis alsinastrum.—Now too abundant in our canals, and fast spreading into the Shannon and other rivers communicating with them. It has to be dredged out of the canals to prevent its obstructing the navigation, and is then in many places used as manure. I have frequently searched for the male flowers, but without success.

Sagittaria sagittifolia.—In the Grand Canal, west of Longford; and Lough Key, county of Roscommon.

FILICES—FERNS.

Grammitis ceterach is decidedly of local occurrence in the midland counties. I found the variety *sinuatum* growing freely on an old wall near Ballinasloe along with *Cystopteris fragilis.*

Polypodium vulgare, var. *semilacerum.*—On a limestone rock on Carberry Island, Lough Ree, near Athlone.

Cystopteris fragilis.—Near Ballinasloe, and also west of Woodlawn, county of Galway; very abundant in several parts of the county of Roscommon, both on roadsides and in chinks in the limestone rock; on roadside south-west of Ballymore, county of Westmeath.

Polystichum angulare, P. aculeatum, P. lobatum.—All abundant in shady hedges. Near Aughrim, county of Galway, the variety *lonchitioides* is very plentiful and well marked, some plants at a first glance looking extremely like *P. lonchitis.*

Lastrea oreopteris.—There are few localities in the midland counties suited for the growth of the Mountain Fern; I have, however, met with it lately growing sparingly on Slievebawn Hill, county of Roscommon, on the Old Red conglomerate, and on Silurian shales.

Lastrea fœnisecii.—Bree's Fern occurs plentifully at the edges of bogs and in shady places on siliceous or earthy soils. It seems to avoid a pure limestone soil.

Hymenophyllum Tunbridgense.—At a former meeting of the Society I recorded the occurrence of this Fern on conglomerate rocks in the neighbourhood of Longford. I have since searched similar places, apparently well suited for its growth, but without success. It grows in the greatest luxuriance in the gneissose hills, on the south side of Lough Gill, near Sligo, so that it is not improbable that the plants of the Longford station may be a waif from Sligo.

Asplenium ruta-muraria, var. *attenuata.*—I also recorded at a former meeting the occurrence of a well-marked variety of *A. r. muraria*, on a wall near Athlone.*

Botrychium lunaria.—By no means common in the midland counties. I met with it on an esker, a few miles north-east of Athlone. Some years ago I saw plants gathered at Doon, King's County.

Ophioglossum vulgatum.—Very abundant in pastures all through these counties.

LYCOPODIACEÆ.

Lycopodium selago.—Common in all the bogs.

L. selaginoides.—Very abundant on the shingly shores of the Westmeath Lakes, particularly Lough Ennel; on the mossy slopes of the canal cuttings near Mullingar.

Isoëtes lacustris.—Abundant in the shallow waters near the edges of all the lakes.

I have not gone into the Algæ, but I could not help observing the following—

Nostoc commune.—In abundance in the hollows of limestone rocks in the county of Roscommon.

Chætophora endiviæfolia.—In wet crevices of the rocks, and at the edges of springs and streams in the same county.

Batrachospermum moniliforme.—Very abundant in the River Suck, near Ballinasloe, and in the same neighbourhood.

B. vagans.—Plentiful in Cloghan Lough, a bog pool on the east side of the River Suck, near Ballygar, county of Galway.

Mr. Foot's paper was illustrated by dried specimens of some of the rarer of the plants mentioned in the foregoing list.

Dr. Moore said, he considered the paper just read a very appropriate one for the Natural History Society of Dublin. Although to the experienced botanist the plants noticed might not at first seem to possess much interest, judging from their comparative rarity in Ireland, they were important in a distributive point of view, their habitats being in the midland counties, which were less known to naturalists than the seaboard counties. He had some experience of this fact lately, when endeavouring to collect data for a small work about to be published on the distribution of the Irish plants. He and the gentleman with whom he is associated in this undertaking, had procured good lists of the plants which grow in most of the seaboard counties, but could obtain very little assistance from persons in the midland counties, which in many instances would have to be left blank in the first edition, consequent on the small amount of valuable information they had got. In this respect he therefore considered the contribution of Mr. Foot valuable; it being from such observers as he, who are in the country during the whole year, we are likely to get faithful lists of the plants which inhabit different localities, and not so much from those who make merely annual excursions to the more interesting portions of the country, which for the most part are pretty well known already. As an instance of this, he might state that during the present year a very important addition to the Flora of Ireland, and also of Britain, had been made by a young lady residing in the county of Galway. He alluded to *Neotinea intacta*, a pretty orchidaceous plant, which was discovered at Castle Taylor during the first week in May. Had the lady not been on the spot at that early period, the plant would have still remained unknown to us as an inhabitant of the British Isles, as it speedily disappears after flowering, and not a vestige of it is to be seen in June or July, when botanists generally think of making excursions. It might not be inappropriate to mention another interesting addition which had been made to the Irish and British Floras during the present year by himself. When at Brandon, in the county of Kerry, collecting mosses and Hepaticæ to send to German correspondents, he visited a large lake near Castlegregory, which seemed inviting to the botanist from its position in Tralee Bay. In it he discovered for the first time *Potamogeton nitens*, a plant long known to inhabit the Continent of Europe, though previously unknown to the British Isles. These facts were encouraging to the young botanists who are members of the Natural History Society of Dublin, showing as they do that the careful observer has yet something to expect for his trouble. Besides, our young friends have it in their power to add many important data connected with the geographical distribution as to our plants in this country, which is so peculiarly circumstanced that the extreme outliers of the South American Flora reach the south-western counties, and there meet the outliers of the Flora of the Pyrenees and other Continental countries. In concluding these remarks, he would only further observe that he considered the thanks of the Society due to Mr. Foot for the communication just read.

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* "Proceedings of Natural History of Dublin" (1862-3), vol. iv., p. 58.

Mr. Archer then drew the attention of the meeting more particularly to the forthcoming work alluded to by Dr. Moore, and distributed copies of the prospectus amongst the members present. The first edition of the book is to be entitled "Contributions towards a *Cybele Hibernica*," and is being prepared under the authorship of Dr. D. Moore, F. L. S., and of Mr. A. G. More, F. L. S., who have undertaken the task free of all expense; and, as is implied by the title, it is intended to be a catalogue of Irish plants with regard to their geographical distribution in the provinces and counties, as sketched out by Professor Babington, of Cambridge, in a paper read before the Dublin University Natural Science Association in 1859. The work will, for the present at least, be restricted to flowering plants; and it is proposed that it should be circulated amongst botanists throughout Ireland, in the hope of exciting some interest in the subject, thereby collecting, too, additional materials to assist in filling up the blanks which must doubtless occur in regard to various as yet comparatively little known parts of the country in a botanical point of view, and thus enabling the authors at some future time to produce, in the form of a second edition, a more perfect "Cybele,"—one that may indeed serve as a supplement, as regards the Flora of Ireland, to the valued and well-known "Cybele Britannica" of H. C. Watson. The "Contributions" will form a demy 8vo volume, about the same size as that of "Babington's Manual of the British Flora," with a map of Ireland, divided into provinces. It is proposed to distribute copies to such individuals as will undertake to supply the desired information, on their engaging to send them back to the authors, so as to enable them to arrange the second edition. Subscribers of £1 to the Publication Fund will receive two copies of the work, when published; and subscribers of 10*s.* will receive one copy. For the forthcoming work, which has been a *desideratum,* and which must commend itself to all interested in botany, the following will gladly receive subscriptions:—D. Moore, Ph. D., F. L. S., Botanic Garden, Glasnevin; A. G. More, F. L. S., Ryde, Isle of Wight; E. P. Wright, M. D., F. L. S., 5, Trinity College, Dublin; William Archer, 21, Upper Pembroke-street, Dublin; or Messrs. Hodges, Smith, and Co., Booksellers to the University, Grafton-street, Dublin. A list of subscribers will be published.

Mr. Andrews said that he must fully concur in the statement made by Dr. Moore with reference to the paper from Mr. F. J. Foot. It was very desirable that we should possess accurate botanical notes of each district or locality in Ireland, and especially with reference to the habitats of plants geologically, and to the extent of their distribution, as forming links of connexion with Continental species, or with those of other parts of the world. Mr. Foot had enumerated a list of plants in the midland counties, which were generally found in the carboniferous limestone formation, which spreads over extensive ranges in the inland counties. Mr. Foot, from his position on the geological survey, had the most ample means of accurate information, and opportunities of examining our native plants, more particularly those early flowering plants of the limestone, which, often unnoticed, pass away before botanists in general have time at their disposal to look for them. Not many years since it was too much the custom to rest satisfied with the decisions of a few individuals on all branches of natural history; and when the "Flora Hibernica" was produced, none would venture to suppose that plants could be found to exist in the country beyond those recorded in that excellent authority. From year to year, however, many important facts have proved the contrary. It was therefore very essential that the publishing of a "Cybele Hibernica" should receive from us every assistance; and it would be highly necessary that such a system of publication should be extended to all the departments of natural history of this country. It was no unusual instance to see works emanating from the English press purporting to be "Histories" of such and such branches of natural history of Great Britain and Ireland, whereas, if we search the latest publication of the day, we should find how incomplete they were with regard to this country. Other features with regard to our labours here, and which are not creditable to us, are the constant references to the authorities in England for decisions on different points of discoveries made in this country. We have men of science among us, who are competent to work out correctly such seeming difficulties; and beyond reference for comparison to more extensive museums or collections, we have ample intelligence to arrive at accurate conclusions. The book now proposed, a "Cybele Hibernica," should have his cordial support.

V.—ON ENTOZOA FROM SOME ANIMALS IN THE ROYAL ZOOLOGICAL GARDENS, PHŒNIX PARK, DUBLIN. By ARTHUR WYNNE FOOT, M. B.

[Read before the Natural History Society of Dublin, December 2, 1864.]

THE first specimen of these parasitic animals which I now bring forward is a portion of a broad Tapeworm, which was found in the den of the Polar Bear (*Thalassactos maritimus*). The piece is twenty-five inches in length, composed of numerous segments slightly overlapping each other, so as to give a kind of serration to the lateral margins of the worm. Their average lateral width is half an inch, and their vertical width the twelfth of an inch. The segments are sexually mature, being each crowded with ova. The reproductive orifices are situated in the median line, the series of the genital pores making a very perceptible dusky streak running down the centre of the chain. The whole appearance of the worm justifies the characteristic name sometimes given to the broad Tapeworm in Germany of Bandwurm or Ribbonworm.

It is a general observation that in the Bothriocephali whole series of segments pass off spontaneously, but never single segments, as in the Tæniæ.* This series of segments on the table seems to be from the central part, or from near the lower extremity of the animal, the anterior part of the typical species being very narrow, enlarging gradually from above downwards, till, about the six-hundredth segment from the head, according to Leuckart, the first sexually mature joints, or proglottides (as Dujardin called them)† commence. There is, however, a case exceptional to the gradual increase in lateral width of these worms in the recently described *Bothriocephalus cordatus*, which is figured in Cobbold's fine work on "Entozoa." In this worm the increase in width is so rapid, that the anterior end of the body becomes lancet-shaped, and only about fifty joints are immature.*

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* Küchenmeister's "Manual of Parasites" Syd., Soc., p. 105.

† "Annales des Sciences Naturelles" (1843), t. xx., p. 341.

These twenty-five inches of parasite form a portion of the strobila of some variety of the broad Tapeworm, strobila being the name given by Van Beneden to the entire collective series of segments, mature and immature, which form the jointed compound body in this class of animals. Beside it there has been put, for the sake of contrast, seventy-two inches of the narrow Tapeworm passed by one of the Dublin city police after the administration of castor-oil and turpentine.

The occurrence of the broad Tapeworm in the Polar Bear suggests the interesting inquiry, are the animals of Northern Europe as subject to this parasite as we know the human inhabitants are; and will locality enable us to predict the existence of this worm in animals, as it will in men?

All the parasites known familiarly by the name of Tapeworms were grouped by Rudolphi under the name of Cestoidea, from their flattened band-like appearance. 250 distinct forms of cestoid worms have been described; and Cobbold, assuming that we may rely upon at least 200 genuine species, has proposed the division of Rudolphi's group Cestoidea into families:—

$$\text{Cestoda}\quad\left\{\begin{array}{ll}\text{Tæniadæ} & \text{(Fam. i.);}\\ \text{Bothriocephalidæ} & \text{(Fam. ii.);}\\ \text{Tetrarhyncidæ} & \text{(Fam. iii.);}\end{array}\right.$$

a classification which is recommended as much by its simplicity as its utility. To the first family—the Tæniadæ— the specimen from the human subject belongs; to the second family—the Bothriocephalidæ—the specimen from the Polar Bear belongs. The Bothriocephali being no longer regarded as species of the Tæniæ, but a distinct family, the old Linnæan title of *Tænia lata*, adopted to indicate the broad Tapeworm as distinct from the narrow one, is falling into disuse, being supplanted by the name Bothriocephalus, derived from the very peculiar pits or grooves near the head, which constitute an anatomical distinction between the two families.

The *Bothriocephalus latus* of man, first correctly described by Bremser,† is not only confined to the inhabitants of Europe, but is even limited to certain parts of that Continent. Foremost among these, according to Leuckart, are the Cantons of West Switzerland, with the adjacent French districts. In Geneva, according to Odier, almost a fourth part of all the inhabitants suffer from *Bothriocephalus latus*. It is also common in the north-west and north provinces of Russia, Sweden, and Poland. The few instances in which this worm has been found in America were all cases of importation by travellers.*

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* Cobbold, *op. cit.*, p. 299.

† Küchenmeister, *op. cit.*, p. 96.

The geographical distribution of the Bothriocephalus of man being certainly limited, we are in search of evidence to show if such is also the case with the Bothriocephalus of the lower animals. There are some facts which seem to admit of such a supposition. The *Bothriocephalus latus* itself, according to Pallas, quoted by Leuckart, is not rare in the dogs of Southern Russia, and Von Siebold has received it also from a dog in Pomerania. Linnæus observed it also in Swedish dogs. The *Bothriocephalus cordatus* has been found in considerable numbers in the dogs of North Greenland, as well as in the human population. Of twenty specimens recently described by Leuckart, nineteen were from dogs, and one from the human body.† The portion of Tapeworm passed by the Polar Bear—an inhabitant of those parts of Europe where men are subject to the broad Tapeworm—is undoubtedly a part of one of the Bothriocephalidæ; but whether it is the *Bothriocephalus latus* of man, or to which of the twenty-five species of the genus it belongs, is difficult to decide in the absence of the head or the anterior part of the strobila.

The development of the Bothriocephalidæ is not so completely made out as is that of the Tæniadæ. In accordance with the general plan of generation in the cestoid worms, the ova contained in the ovary of a mature segment, or proglottis, of the broad Tapeworm, must find their way into the body of some other animal, in which they will be developed to a certain degree, and no further, until that animal has been devoured by some other, belonging to a higher species, to whose intestine when they have been transferred, these hitherto only partially developed worms will there attain their perfect and final condition. What the animal is which receives and partly developes the eggs of the broad Tapeworm, and which when eaten by man will be the means of introducing into his body the *Bothriocephalus latus*, is the link which is wanting. We know that link in the case of the common Tapeworm—it is the pig. We can only conjecture it in the case of the broad Tapeworm. There are reasons for believing that it is from fish the inhabitants of those parts of the Continent of Europe where the parasite is endemic are infected. It appears that the ova of the Bothriocephalidæ are not capable of developing an embryo after their escape from the ovary of the mature segment until they have been immersed in water for a period of from four to eight weeks.‡ After the expiration of this variable period, the lid with which the egg is furnished opens, and permits the escape of a fully developed ciliated embryo, which, after the rotatory fashion of Volvox, swims about for several days, when the ciliated envelope bursts, allowing the exit of a six-hooked non-ciliated embryo. These

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* Weinland, "Essay on the Tapeworms of Man," p. 59, quoted in Cobbold's "Entozoa," p. 292.

† Cobbold, *op. cit.*, p. 299.

‡ Ibid., p. 293.

sets have been described and figured by Leuckart. The embryo now only wants to find a suitable host, within whose body it may attain its larval or encysted form; it is fully prepared, as soon as it obtains an entrance, to maintain its position by the coronet of hooks with which its anterior extremity is armed. There is under the microscope the head of an encysted worm from the peritoneum of a Callithrix monkey, which, though the immature form of a narrow Tapeworm, serves to illustrate the manner of anchorage of the larva of Bothriocephalus; for in this phase of their existence the embryos of Tæniæ and Bothriocephali are precisely similar, widely different as are the forms of the so-called "heads" of these worms subsequently.* I have also put on the table a carmine injection of the uterus and testicles of a Tapeworm, and a specimen showing the ovary and eggs of a mature segment of the worm from the Polar Bear. The hosts which answer the purpose of the young Bothriocephali found in animals are some of the marine Vertebrata; for many cestoid worms are known to pass their larval or immature stage in the liver or peritoneum of fish, where they become encysted, and increase in size, but do not become sexually ripe from the absence of the conditions necessary to the attainment of this state; and should their hosts, the fish, perish without having been devoured by an animal of prey, the sexless cestoidea will perish with them without leaving any progeny.

To Von Siebold we are indebted for much light on this subject. He observed that in certain neighbourhoods the sticklebacks were infested by a kind of tænoid parasite, which lies free in the cavity of the abdomen, and often distends the body of its host to an unusual size. As long as the parasite remains in the stickleback its joints and sexual apparatus remain undeveloped; but in the intestine of many of the water fowl, herons, gulls, and divers, which prey on these sticklebacks, a sexually-matured Tapeworm, recognised by the name of *Bothriocephalus nodosus,* had been known to exist. He discovered that this matured worm was the parasite of the stickleback in its further and final stage of development, entered upon as soon as its former host, the fish, had been digested in the bird's stomach, this process having released the larva from its intra-capsular imprisonment. An encysted worm is found in the liver and peritoneum of certain species of salmon, which will not become mature until it has obtained entrance into the intestine of the pike or perch, where it becomes the broad Tapeworm known by the name of *Triaenophorus nodulosus.* Another example occurs in the case of *Ligula simplicissima,* infesting the abdominal cavity of various species of carp, whose sexual organs are and remain undeveloped as long as the worm resides within the fish; whereas when the latter is eaten by ducks, waders, or other water fowl, the entozoon conveyed into their intestines attains perfect sexual development. Though these facts do not throw much light on the early history of the *Bothriocephalus latus* of man (for, except in the case of the red mullet, where some of the intestines are considered a delicacy, we are not in the habit of eating the parts of fish in which the larval form of the worm dwells); they account for its discovery on one occasion by Creplin in the cat, which eats with relish the refuse of fish.* The Polar Bear in the Zoological Gardens has been in the habit of getting, among other food, three pounds of fish, generally conger eel, every day for several years; and we may be allowed to conjecture that it is from this source he has derived the semi-developed animal which in his interior became matured into a full grown Bothriocephalus. There are other animals in the Gardens, as the Seal, fed with the flesh of the conger eel; but it does not follow that the embryos must be in them developed into broad Tapeworms; for every species thrives and undergoes its metamorphoses only in a particular and appropriate species of animal, as in the case of the encysted worm, *Cysticercus pisiformis,* found in the liver and peritoneum of hares: if it be eaten by a dog, it will be developed into the *Tænia serrata ;* if it be eaten by a gamekeeper or poacher, it will be developed into the *Tænia solium ;* if it be eaten by a cat, there will be no jointed Tapeworm developed at all—the Cysticercus will die in a short time.

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* Von Siebold on "Worms," Syd. Soc., p. 35.

Perhaps it is on account of his northern origin that this development has taken place in the Polar Bear. He comes from latitudes where the broad Tapeworm is common, and the narrow Tapeworm rare, as far as man is concerned. There may be something in his organization, in virtue of his Arctic parentage, to account for the fact, that the fish of the British seas, containing, as some of them do, elements capable of being developed into broad Tapeworm, can originate in him a Bothriocephalus; but cannot—or very rarely do so—in the British animals, as cats, for instance, which feed on the same fish in these latitudes. This Polar Bear has been six years in the possession of the Zoological Society; and it may be said that he brought the worm with him from his northern home, for these animals are remarkably fond of fish, and especially of salmon, in which an embryo, capable of being developed into a broad Tapeworm, resides; and so active in the water are these Bears, that they have been seen to catch a salmon in its own element; yet men and lower animals eating salmon freely in Great Britain do not get broad Tapeworm. The Russians are particularly fond of eating raw salmon, which they wash down with a "botka," or measure of brandy, no doubt with the view of counteracting the unpleasant effects such food may give rise to. The President of this Society has, when travelling in that country, eaten as much as half a pound of uncooked salmon. Dr. Huss, of Sweden, attributes the frequency of *Bothriocephalus latus* on part of the Lapland frontiers, in Finland, and on the shores of the Gulf of Bothnia, to the use of salmon.

It is very remarkable, in connexion with the aquatic nature of the early life of the Bothriocephalidæ, that, as Küchenmeister remarks, the present geographical conditions of all the places where men are subject to the broad Tapeworm can be looked at in a common point of view. They all lie in low situations, and in large marshy districts, on the shores of rivers and lakes, or of the sea, and especially in places liable to inundation, all pointing to the piscine origin of the infection.

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* Küchenmeister, *op. cit.* p. 103.

I have brought this worm before the Society because the Bothriocephali, to which I have no doubt it belongs, though found in the intestines of higher fishes, or of the marine birds of prey which feed upon those fishes, are extremely rare in all terrestrial Mammalia.* Of the six specimens in the College of Surgeons of England, one is from a native of Switzerland; one from a Russian, belonging to the Russian embassy; one from a person who had been travelling in Switzerland; a fourth happened in the practice of Dr. Gull, in the person of a little girl from Woolwich, where there is always a number of foreign ships and sailors, bringing with them native food and water; another was passed by a native of Russia, who, after a long residence in England, paid a temporary visit to his birthplace, and returned to England with this parasite as a pleasant memento of his native country.†

The *Tænia solium*, or narrow Tapeworm, has been observed in inhabitants of St. Petersburgh after the adoption of a raw meat diet, as, for instance, after the treatment of Weisse for diarrhœa; and in the cases that were met with it was explicitly stated to be the *Tænia solium* that was expelled. Von Siebold‡ remarks that "the statements would have been much more to be suspected if in the Tapeworms that were passed the *Bothriocephalus latus*, so general in Russia and Poland, had been recognised, since this worm is never met with amongst our cattle in a scolex condition."

In the "Medical Times and Gazette" for September, 1861, there is an account of the sufferings of a Polar Bear, in the Zoological Gardens of Dresden, from a species of broad Tapeworm, perhaps identical with this one. The Bear, which was only a few months old, was one day seen to run about in his cage in a state of great alarm, dragging a long white thread after him, of which he in vain endeavoured to get rid. One of the keepers tried to quiet the animal by petting it, while the other rolled the thread upon a stick, and thus removed as much of it as possible. The keepers saw that it was a worm; but having placed it in water instead of spirits, in a few a days after, when it was handed over to Küchenmeister for examination, it had become entirely decomposed, and no joints were to be recognised. A microscopical examination of the fluid showed oval-shaped eggs, with lids. Küchenmeister concluded that the infection had taken place from the fish with which the Ice Bear was fed. Soon after the first part of the worm had come away, a second discharge took place, and a few yards of a very broad Bothriocephalus were brought to Dr. Küchenmeister. It was then ascertained that the Director of the Zoological Garden had been advised to feed the Bear upon bread and fish, in order that he might safely get over the infantile diseases. The animal had recently received some fresh meat, with cod-liver oil, in consequence, perhaps, of which the Bothriocephalus had come away. The pieces of the worm examined by Küchenmeister quite resembled that found in man, only being broader than the broadest specimen of the human worm yet examined.

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* Küchenmeister, *op. cit.*, 103.

† Aitken's "Practical Medicine," 1st ed., vol. ii., p. 91.

‡ Von Siebold on "Worms," Syd. Soc., p. 87.

VI.—ON A MODE OF FISSIPAROUS REPRODUCTION OBSERVED IN ANTHEA CEREUS. By EDWARD H. BENNETT, M. D., CH. M., F. R. C. S. I.

[Read before the Natural History Society of Dublin, January 6, 1865.]

I HAVE adopted the title of this paper, which is printed on our list for this evening, in order that I might avoid the danger of being charged with bringing a well-known fact before the Society as anything new. I am well aware that fissiparous generation has been often observed in the Class Actiniæ; but, as far as I can see, the mode of division which I am about to describe has not been recorded—at least, not with any accuracy.

The observation which I have made is as follows:—One morning last summer, in July, I brought to town from the shore at Seapoint three specimens of *Anthea cereus* (the ash-coloured variety), and put them into a large aquarium, already well-stocked. They were uninjured, and at once attached themselves to the stonework of the aquarium, expanding their tentacles to the full. I had on previous occasions failed in getting this species to do well in the vessel, from some fault in its management, and consequently watched these with some interest. During the evening of the day on which they were put into the vessel I was surprised to see one of them, the finest specimen, moving about in a most unusual manner, while the others were quite motionless, and almost concealed amongst the stonework. The species is always rather restless as compared with others, but this individual seemed to be suffering from some extreme excitement, constantly in rapid movement along the stonework, and waving its long ash-coloured tentacles in the wildest manner. Late at night, when I was going to bed, the Anthea was on the highest point of the stonework, in the centre of the vessel; in the morning it was attached high up the front glass of the vessel, and was still in the same state of excitement. Its position on the front of the vessel afforded the best possible opportunity for the examination of its structure and movements. I made a most careful examination of it, and assured myself that it was perfectly free from any injury.

On my return home, at about 3 P. M., I at once examined it, and was surprised to find that there was now in the centre of the base a small, irregular opening; the base itself was no longer circular, but had extended itself in the vertical direction to the utmost, and formed a long narrow oblong. So great was its extension lengthwise, that the column of the animal was almost flat on the glass. The opposite ends of the base seemed to be working to the utmost to increase the distance between them, and the tentacles waved about more vigorously, if possible, than in the morning.

It occurred to me that the meaning of all this excitement and muscular exertion, of the opening in, and the shape of, the base, was, that the animal was attempting to divide spontaneously—was, in fact, in the pangs of a very strange labour. I determined to watch the process, and sat down in front of the vessel.

In a few moments the opening in the base became wider, more irregular, and was evidently increasing from the violence of the muscular efforts of the animal. Presently the opening in the base extended to the margin and up the right side of the column, exposing to view the internal structure—the septa and so-called craspeda. At 4·20, twenty minutes after the rent had reached the margin of the base, it extended to the left side, and so divided the whole base into two nearly equal segments. It is a curious fact that the tentacles corresponding to the two parts now contracted separately; hitherto the contractions were convulsive, and set in suddenly at intervals and all together, now there was a distinct pause between the convulsion of the upper and lower divisions, the upper always preceding the lower by a few seconds. Does not this suggest that the seat of the central nervous system of Actinia occupies the base, as Spix thought he had demonstrated—although this demonstration has been rejected by every authority who has followed him? At 5·10 the walls of the stomach could be seen strained across the fissure, and they presently gave way, the rent extending right through the column to the oral disc. On one margin of the disc the rent involved the base of one of the outer row of tentacles, and extended along it. I was much interested in watching its progress along the tentacle, as it seemed doubtful whether it would tear along its whole length, or detach one or other half from its attachment to the body. The strain seemed great on the parts, and at last the lower half tore off from its base, and, immediately closing into a perfect tube, hung as a branch from its parent trunk. The wound in this, too, seemed to close at once when the strain was taken off. I have mentioned this apparently trivial detail, as it may explain the occasional occurrence of the double or branched tentacle which has been observed in *Anthea cereus*. At 5·45, less than three hours from the commencement of the process, the division was complete, the upper half falling to the bottom of the vessel. At 6·5 the lower followed it, and the two new individuals lay together almost motionless.

Next morning one attached itself to the glass, and showed its base nearly perfect; the other lay much in the same place as the evening before.

I regret that I was unable to continue my observations on these two animals any further—the water in the vessel became turbid, and many of its inhabitants died, including the two Antheæ. They were able to move about for some days, but never with activity. They seemed, however, to have quite closed up their wounds. I could not examine them anatomically, as they were so softened before I removed them from the vessel that dissection was impossible. When removing them, I looked for the others of the same species which I put into the vessel, and I found that these had also tried to divide, and apparently in the same way, from the base upwards.

The observation goes far enough, however, to prove that division was completed, and that the two halves lived as independent animals for a few days. The whole time which the division took, from the first observation of the opening in the base to the complete separation of the halves, was barely three hours. The exciting cause of the process seems to have been the condition of the water in the vessel, just verging on decomposition. The most important part of the observation is the mode of the division.

Before discussing this, I will quote the only case which I have been able to find recorded of a similar kind. Gosse, in his work entitled "Tenby," speaking of the rarity of the occurrence of fissiparous generation in Actinaria, states that he had never seen it occur spontaneously himself, but quotes the following observation of a friend :—"An *Anthea cereus*, which had been in captivity thirteen days, devoured with great relish a dead shellfish. I watched the operation of seizing and swallowing, and there was nothing remarkable in the appearance of the Anthea on Monday. On Tuesday morning, going to look at my prisoner, I observed the rejected shell at the bottom of the jar; and to my great puzzlement, instead of one Anthea, there were two, of nearly equal size, but smaller than my old friend. Both appeared languid, and, from the margin of one, two tentacula appeared sprouting; they hung in so very flaccid a state, that I could not examine the mouth yesterday, but to-day one exposes a mouth fully formed." We have little else recorded here than the fact of the division and its extreme rapidity. There can be little doubt that in this case, as in mine, the division was effected by muscular action.

Nearly a century ago Decquemare observed that several Actiniæ could be divided artificially in almost any way, the several parts being capable of forming independent animals. Sir J. Dalyell has recorded a mode of reproduction in one species—*Actinia lacerata*—accomplished to some extent, apparently in the same way, by muscular action, as in the case I have described. He describes, in this species, the outline of the base becoming sinuous, and the prominences gradually, in the course of a week or two, becoming pinched off, maintaining their connexion only by a very slender lengthened filament, not in contact with the glass, but free above it. Rupture of the connecting thread at length takes place, and the independent fragment becomes developed into a perfect anemone. He says of the process :—"It is not quite obvious how the prolongation is effected, unless by contraction of the basis, and recession of the fragment from the point it originally occupied. All authorities agree, as far as I can find, in stating that fissiparous generation occurs either in the way described by Dalyell—by separation of a part of the margin of the base—or by division from above downwards, not from below upwards, as I have described." Milne-Edwards says :—" Spontaneous fissiparous generation occurs either by detachment of fragments from the inferior border of the body, which, continuing to live, become developed into perfect animals, or at other times division commences by a narrowing or strangulation [*etranglement*] of the superior extremity of the body, which, becoming more and more pronounced, causes a bifurcation, the branches of which complete themselves, each on its own side, so as to constitute two distinct individuals. These may remain united by the base, and so cause an aggregation of polypes, or may be separated completely." This mode Dalyell has observed and figured in Actinia. Dalyell is the only authority, as far as I know, who attributes the separation of the fragments, in any case, to muscular action.

How the process is effected when it occurs in the more common way —from above downwards—I cannot imagine, unless it be similar to ulceration in the higher animal, or else is due to muscular action. I am not certain whether any definite idea of the process is expressed by Milne-Edwards in the word *etranglement,* which I have quoted above. Gosse evidently attributes it to a process of growth. He says :—" The greater part of the Astræacea increase by disc buds and spontaneous subdivision, the disc of the polype gradually widening by growth, and finally separating into two portions, which become independent." Whatever be the means by which the separation is accomplished in the greater number of cases, it was evident that, in the exceptional case I have recorded, the animal absolutely tore itself into halves; and further, that the division occurred in a direction from below upwards, the reverse of that which is supposed by some to be the constant mode in the class.

I have thought the case worth recording, as affording some clue to the explanation of a physiological process which is very imperfectly understood, and on account of its novelty.

Dr. Barker suggested the possibility of the animal, in the very interesting case brought forward by Dr. Bennett, having been accidentally injured at its base in its removal from its native habitat, and that such injury might have been a predisposing or exciting cause of the commencement of the process which Dr. Bennett had described, which had ended in complete division of the original animal into two; or at least such an injury might, perhaps, have determined the point at which self-fission originated.

Mr. Andrews considered the process of fissiparous division of this animal (common on the rocks of the sea coast, and very abundant in the south and west) must be regarded as quite normal; and the actual mode in which the process was carried out, as described by Dr. Bennett, was very interesting. Several years ago, however, Professor Allman had recorded in this Society the fact itself, as well as the oviparous reproduction of the animal, and its stinging properties, although the credit of the first notice of it, he (Mr. Andrews) believed, has been attributed to more recent observers.

Dr. Bennett said that, having carefully examined the animal, as he had stated, he found it to be quite uninjured by its removal—in fact, it had travelled in the aquarium a distance of about three feet, which, had it suffered any injury, it could hardly perhaps have done.

VII.—FURTHER OBSERVATIONS ON ENTOZOA FROM SOME ANIMALS IN THE ROYAL ZOOLOGICAL GARDENS, PHŒNIX PARK. By ARTHUR WYNNE FOOT, M. B.

[Read before the Natural History Society of Dublin, January 2, 1865.]

THE communication which I had the honour of reading before the Society at its last meeting had reference to the adult, fully formed, and mature Tapeworms of the broad and narrow varieties. I wish now to bring before your notice some specimens of the encysted or larval condition of one class of those parasites; some of them were taken from the body of a Callithrix monkey, and others from a Russian rabbit.

The occurrence of the cystic worms in man and other animals was known to the ancients, although of the animal nature of these structures they were in complete ignorance. Aristotle, in his "Historia Animalium," speaks of the Cysticerci of the pig as a disorder which had been known for ages;* yet in comparatively modern times great mystery hung over the origin and meaning of these formations, for we have John Hunter asking, "Do these hydatids proceed from cold or indolence?"† and Dr. Bright, when writing of abdominal tumours, saying, "Of the origin of hydatids we are so completely ignorant, that it would be vain to hazard a conjecture on the subject."‡ With reference to their origin even Andral expresses himself in favour of the now refuted doctrine of equivocal generation—namely, that from external mechanical influence, such as a contusion affecting an organ, its necessary nourishment may be disturbed, so that the organic particles are not fully assimilated, and become metamorphosed into lower kinds of animals; for example, into a Cysticercus.§ The cystic worms were elevated to the rank of an Order by Rudolphi, in his classification of the Entozoa. Of this honour they have been deprived, since a better acquaintance with their natural history has shown that they have no claim to be regarded as an independent group, being, in fact, the Tapeworm in a partially developed form.* Dujardin, in 1845, was the first to assert that the cystic worms were undeveloped forms and young states of the Tapeworm.† Simultaneously Von Siebold in Germany expressed the same opinion. Küchenmeister was the first, in 1851, to administer the cystic worms to animals. He succeeded in rearing mature Tæniæ in the dog from the *Cysticercus pisiformis* of the rabbit, and in the cat from the *Cysticercus fasciolaris* of the mouse. The converse of this experiment, the production of cystic worms from the ova of a mature Tapeworm, has since been effected by Leuckart and others.

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* Küchenmeister's "Manual of Parasites," Syd. Soc., p. 14.

† Hunter's "Essays and Observations," by Professor Owen, vol. ii., p. 489.

‡ "Clinical Memoirs on Abdominal Tumours," Syd. Soc., p. 11.

§ "Grundriss der Pathol. Anatomie," vol. i., p. 393.

When a rabbit has been fed with ripe segments of the *Tænia serrata* of the dog, in twenty-four hours a microscopic examination of the blood of the portal and other abdominal veins will show an immense number of minute embryos, armed with hooks, corresponding in size to the ova of *Tænia serrata*. About the fourth day small white semi-transparent vesicles, each containing a little white embryo, make their appearance in the liver. Eight days after the administration of the worms the liver presents a more or less spotted appearance, conspicuously visible to the naked eye. Soon after the passage of the six-hooked embryos out of the blood into the liver the metamorphoses by which the embryo is transformed into a Cysticercus appear to commence. Round the vesicle of the Cysticercus the liver forms a capsule of connective tissue in self-defence, within which the formation of the head of the larva proceeds. Many of the embryos deposited in the liver do not come to maturity, but die, and undergo a change into granular atheromatous masses.‡

The cystic Entozoa have been arranged into various genera, founded on peculiarities in the containing vesicle, or in the contained scolex—the future head of the fully formed worm. The presence of a caudal vesicle makes the genus Cysticercus, and of this genus there are several species, distinguished for the most part by the forms and proportions of the neck or body intervening between the head and the caudal vesicle; as, for example, *Cysticercus fasciolaris*, *Cysticercus longicollis*, *Cysticercus tenuicollis;* the genus Cænurus is so called, because the terminal cyst is common to many bodies and heads. Another kind of tænoid embryo becomes metamorphosed into a vesicle of larger or smaller dimensions, from whose inner surface countless scolices pullulate; these, however, become detached, and lie freely within the cavity of the parental vesicle. Upon this form the genus Echinococcus has been founded; the name was given by Rudolphi on account of the cylinder of hooks which surrounds the heads of the microscopic animals. These three genera of cystic worms were till lately all confounded together under the name of hydatids. In 1804 Laennec gave the name Acephalocyst to the so-called hydatids, which are found containing no scolices or heads at all. These organisms are regarded by Küchenmeister as the product of six-hooked cestode embryos, the growth of which has proceeded without hindrance, but which, nevertheless, have remained barren, never having attained to proliferation and the production of embryos.*

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* "Cyclop. Anat. and Physiol.," vol. ii., p. 115.

† "Hist. Nat, des Helm.," pp. 554-633.

‡ Cobbold, "Entozoa," p. 110.

Attached by separate pedicles to the great omentum of the Callithrix monkey were four whitish globular bladders, nearly the size of plovers' eggs, transparent enough to allow of the white anterior part of a worm to be seen coiled up inside them. When the outer envelope, formed of condensed connective tissue, was carefully snipped, a second interior bladder still remained, the tail vesicle of the cystic worm. The worm when removed from its envelope measured, from the head to the end of the emptied and collapsed bladder, two inches and three-eighths; the anterior end was furnished with a round knob, wrinkled transversely, having a cephalic pit in its centre, from which was made to protrude a head armed with suctorial pores, and a double crown of hooks. The liver had several cysticercal capsules in a state of degeneration; their locality was indicated by excavations containing a granular atheromatous *débris* enclosed in a condensed areolar capsule. These marked the graves of Cysticerci, which, unsuccessful in obtaining admission into the body of an appropriate host, after remaining for some time fully developed as larvæ, began to degenerate, and eventually cretified within the shrivelled capsule. Except in their cysticercal condition, Tapeworms are not very prevalent in the Quadrumana, in which respect these latter have the advantage of man, whose bodies are invaded by ten species of mature Tæniæ. The liver is especially the primary seat of encysted worms, more because the blood of the intestinal veins, into which the ova find their way, must pass through that gland, than from any power or inclination on the part of the animal to select that organ for its temporary habitation; accordingly, in order of parts in man infested by hydatids, according to Rokitansky, the liver holds the first rank, followed by the sub-peritoneal areolar tissue, the omentum, the muscles of the heart, brain, spleen, kidneys, lungs, bones;† and, according to Davaine, the liver itself offers more cases of hydatids than all the other organs put together.‡

In the Russian rabbit, one bunch of capsules invested in a common envelope of cellular membrane was attached to the gastro-hepatic omentum, and another bunch was situated between the urinary bladder and rectum. The Rodentia have long been known to be a favourite host of the larval forms of Tapeworms. Küchenmeister considers that it is not improbable the Mosaic prohibition of certain kinds of flesh for food was founded upon a knowledge of the parasitic diseases it would occasion; and observes that, to the naturalist at least, it must appear remarkable that there are mentioned as unclean, immediately after each other, three animals—the pig, the hare, and the shaphan—which are still universally known as bearers of Cysticerci.* The old commentators agreed in translating the word shaphan, rabbit; and though modern writers are not unanimous as to the exact animal alluded to, all refer it to some member of the Rodentia—a family particularly characterized by harbouring Cysticerci. In a dietetic point of view the frequent infection of rabbits with cystic worms is interesting to us. Though many quadrumanous animals are highly prized as articles of food in their native countries, in this land prejudice and motives of economy forbid their consumption, so that we have not opportunities of studying the development of the Cysticercus of the monkey in the human intestine; but it is well known that the flesh of the rabbit is a prolific source of Tapeworm in men and dogs who consume many of these animals. When properly roasted or boiled, however, it may be eaten with impunity, the high heat to which the flesh is submitted destroying the vitality of the embryos.

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* "Man. of Parasites," Syd. Soc., vol. i., p. 230.

† "Path. Anat.," p. 361.

‡ "Traité des Entoz.," p. 375.

Some of our domestic animals, as horses, oxen, and especially sheep, are terribly plagued by the presence of an encysted worm belonging to the genus Cœnurus. The effects of this animal, the larval form of one of the six species known to inhabit the dog, constitute the symptoms of the disease variously called staggers, sturdy, turnsick, goggles, and vertigo. The peculiar symptoms are due to pressure on the nervous matter of the brain or spinal cord by the growth of this cystic worm, which almost invariably selects the nervous centres as its nidus. The brain hydatid, or brain bladders, as they are called by herds and butchers, vary in size from a pea to a pigeon's egg, and are often much larger. They contain countless microscopic Tapeworm heads, armed with hooks and suckers, connected by narrow stalks to the common vesicle supporting the colony.† That the connexion between the *Tænia cœnurus* of the dog and the brain hydatid of sheep is one of cause and consequence has been proved by Küchenmeister and others, who showed that the administration to young lambs of the ripe segments of this Tapeworm, derived from the dog, produced Cœnuri, or brain hydatids, in the animal fed with them, and in return the administration of the hydatids to dogs produced the *Tænia cœnurus*. The space of time is not long between the introduction of ova into the sheep and the exhibition of their effects. Dr. Haubner, Professor at the Veterinary School of Dresden, fed several lambs with perfect joints of the Tapeworm of dogs on the 7th of January, and on the 20th the first appearances of the staggers manifested themselves.‡ The extreme prevalence in Iceland of the disease of staggers has long been known. The islanders keep large quantities of sheep and horned cattle; for every one hundred inhabitants of Iceland there are eleven hundred head of horned cattle, and every peasant has on an average six dogs shut up in a small hovel. With these animals and his stock of cattle he spends the long winter nights, from which results a loss amounting in many sheep farms to more than ten per cent., and the infection of the inhabitants themselves, as well as their herds, with hydatids; for, according to Eschrict, one-sixth of all the inhabitants annually dying in Iceland fall victims to the prevalence of hydatid disease. Leuckart remarks that the treatment of the quack doctors who abound in the island is exactly suited to keep up the epidemic; for amongst their remedies, dog's urine and fresh dog-excrement play a conspicuous part.* It is worthy of remark that those sheep which are stall-fed, and consequently unattended by a dog, are never or very rarely troubled with the *Cœnurus cerebralis.*

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* *Op. cit.*, vol. ii., p. 13. † Cobbold, p. 117. ‡ Von Siebold.

VIII.—ON THE STRUCTURE OF THE EYE OF THE SEAL. By HENRY WILSON, F. R. C. S. I.

[Read before the Natural History Society of Dublin, February 10, 1865.]

I AM indebted to the kindness of the President of this Society for the opportunity of examining the Seal's eye, and for the privilege of bringing under your notice the present communication. As many of you are aware, Dr. Haughton purchases, for scientific purposes, at his own expense, the majority of the animals which die in the Gardens of the Zoological Society; and he furnishes us from time to time, when his other numerous and arduous avocations will permit, with the results of his investigations. Thus many new facts in the province of comparative anatomy have been brought to light, many theories and explanations previously received have been either refuted or confirmed, and, what is of special moment to the Zoological Society, as well as interesting to the medical practitioner, the cause of death is generally ascertained.

The mortality of the Seals in the Zoological Gardens is much to be regretted by the public, as they are amongst the most interesting of the animals in the Collection. The last two appear to have died of starvation, and I believe the disinclination to eat was caused as much by physical suffering, from injuries received in their capture, as from mental suffering in consequence of their captivity. It is to be hoped the next specimen may be obtained uninjured and young.

The Seal is a carnivorous mammal, living partly in the water, and partly on the land; subsisting in adult life, I believe, entirely on fish, molluscs, and other aquatic animal products. Besides the external configuration and modifications suitable to the animal, and the special contrivance whereby the venous blood is retarded in its course to the lungs, and thus the number of respirations diminished, and the animal's power of remaining submerged increased, one of the most interesting peculiarities of the Seal is its capability of seeing in two media of such different densities and refractive power as air and water. The organ of vision, therefore, must possess some special mechanism, whereby this accommodation takes place; and as the subject of distantial adjustment is one of very great importance, as well to the medical practitioner as to the metaphysician; and as the structure and form of the animal's eye may be unknown to some of the Members of the Natural History Society, I have not hesitated in bringing the subject under your notice.

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* Leuckart, quoted in Cobbold, p. 283.

The peculiar arrangement of the case of the eye, to which I wish morc especially to direct your attention, was discovered by Blumenbach. The globe is large; its anterior-posterior diameter is the larger, and measures $1\frac{3}{8}$ of an inch, while the lateral is $1\frac{5}{16}$, or $1\frac{1}{16}$ less. Some time after removal from the orbit, my attention was arrested by a manifest sulcus at the transverse diameter of the globe, so that the ball appered divided into an anterior and posterior segment, the two having fallen together. The sclerotic or protecting case is a dense, firm membrane, enclosing the sensitive and mechanical apparatus; externally it is smooth and polished, and spherieal in shape, in the recent eye. It consists of two wedge-shaped portions, joined at their apices at the transverse diameter—the interior $\frac{1}{2}$ inch in length; its base or broadest part, $\frac{1}{8}$ thick at the junction of cornea, sclerotic, and iris, gradually lessens in thickness from before backwards, until it becomes thin and semitransparent, allowing the dark-coloured choroid to shine through. From this point it gradually increases in thickness from before backwards, until it reaches to the optic nerve, near which it is $\frac{1}{8}$ inch, the same as in front; the length of this portion is $1\frac{1}{4}$ inch. The internal surface of the anterior portion is rough, and appears composed of circular fibres; the posterior, on the contrary, is smooth and polished, and seems composed of longitudinal fibres; in both the thickening appears to take place on the internal surface. The inner surface of the anterior portion has connected and intimately attached to it the ciliary muscle, which is also of rather a wedge shape, $\frac{1}{16}$ wide; it appears composed of simple fibres and connective tissue, the fibres taking a direction from without backwards and inwards towards the choroid. More accurately described, this muscle appears to consist of two separate and distinct bundles of fibres—one proceeding from the cornea, the other from the iris, and joining posteriorly, and leaving between them anteriorly the space known as the canal of Fontana, which space is, I believe, larger in the Seal than in any other animal. The external part of this muscle is that by means of which the curvature of the cornea was said by Sir Philip Crampton (its discoverer) to be altered. These parts are well seen in the section on the table, which has been prepared by steeping in chromic acid. In the same specimen, too, the fibres running from the cornea to the sclerotic may be seen with the unassisted eye. This muscle has attached to it, and assists in forming the suspensory ligament of the lens, and in front the pillars of the iris. The choroid gradually gets thin from behind forwards until it reaches the thin portion of the sclerotic, from whence it continues inwards and forwards, and forms the ciliary processes. The retina ceases at, or rather a little behind, the thinnest part of the sclerotic, at the ora serrata. The lens is large, and almost globular; its posterior surface is, however, more convex than its anterior; its measurements are, as well as I can judge—antero-posterior diameter, $\frac{1}{2}$ inch; lateral diameter, $\frac{9}{16}$ inch. The cornea is somewhat flattened, large, and larger from side to side than from above downwards. It is overlapped externally by the sclerotic. The iris is of a rich, soft brown colour; the pupil wide, and rather circular, and placed somewhat at the nasal side. The animal possesses a nictitating or third eyelid, which is large and moveable; it also has a small retractor or suspensory muscle—a muscle well developed in the ruminants, and in some carnivora—arising from the optic foramen, and inserted by four small muscles into the sclerotic, $\frac{3}{8}$ in front of optic nerve. There are two obliqui and four recti muscles, which latter give me the idea of each dividing into two, one of which is inserted into the anterior segment of the sclerotic, behind the cornea; the other appears to advance to the tegumentary apparatus of the eye, into which it is inserted; of this disposition of parts, however, I cannot speak with confidence, as I have not had an opportunity of seeing the parts *in situ*.

Various theories have been published to explain how distantial adjustment occurs. If our eyes are healthy and normal, we can see clearly and well one and the same object at various distances; our eye adjusts itself to near and distant objects generally without any appreciable effort on our part. The rays of light from a given object must be refracted through the transparent media of the eye, and must come to a focus in the retina or nervous expansion. If from any cause this focus fall either in front of or behind the retina, indistinct vision ensues (if the focus fall in front of the retina, short sight; if behind the retina, long sight results). The causes of accommodation have been assigned to alteration in the curvature of the cornea, to difference in the size of the pupil, alteration in the curves and position of the lens, and to alteration in the shape of the globe, by pressure of the external muscles. Modern research proves that in the act of accommodation the lens is altered in its anterior curve, and in its position; and these changes are attributed to the ciliary muscle, it being generally denied that the external muscles have any participation in the process. I have always held that the external muscles of the eye acted not only as locomotory agents, but that they also, to a certain extent, influenced the accommodation; and I think the eye now under consideration strengthens this belief; for in it there is an arrangement whereby the anterior segment of the globe may be approximated to the posterior. When the animal is in the water, and in search of its prey, I think its sight is perfect; and I believe the recti are then in powerful action, and retract the anterior segment, at the same time that they will, together with the obliqui, compress the globe laterally. In this action the lens will be pushed forward towards the cornea, and the cornea itself possibly flattened. If the ciliary muscle act at the same time in increasing the convexity of the lens, we have this animal's eye assuming the same form and arrangement as the fish's eye. In these motions the posterior segment will, I believe, remain stationary, the anterior moving in relation to it on the thin hinge-like part of sclerotic.

Dr. Bennett observed, that the principal point dwelt upon by Mr· Wilson seemed to be the increased thickening, in the Seal, of the capsule of the eye posteriorly and anteriorly, with a zone passing somewhere near the vertical meridian transversely round the eye, so as to leave the greatest weakness of the wall along that zone. They had at present in this question to deal with very imperfect data. He saw the body of the Seal, but did not make a particular examination of its eyes at the time; but on the facts he had noticed, there appeared to be a curious approximation between the eye of the Seal and those of the other aquatic Mammalia—viz., the Cetacea—namely, an enormous thickening in both of the posterior as well as the anterior parts of the sclerotic. This thickening, in some individuals, amounted to so much as two inches; and there was a fine specimen of it in the Museum of Trinity College. The fact bore especially upon the present question, a Mr. Wilson's theory as to the power of ocular adjustment in the Seal was different from that which was generally received. Mr. Wilson's idea was, that the antero-posterior axis was elongated under a lateral pressure of muscles external to the globe of the eye, that pressure taking effect owing to the weakness of the coat along the middle zone, and the anterior muscles forming a fixed point. His objection to this supposed action of the muscles was, that it would have the effect of shortening the long axis of the eye. He did not believe that the external muscles had anything to say to the focussing of the eye. If they had, it would be by pressing the anterior half of the globe of the eye backwards. All the authorities are agreed that, when we look at a near object, we shorten the eye by muscular exertion. In the eyes of different animals the structure of the external muscles varied in every possible way; and there was an equally great variety in the structure of the external case. In birds there was also an arrangement not unlike that occurring in the Seal, viz., a second cup, set face to face with the posterior one, and at the point where the anterior thickening of the sclerotic occurred. He would ask Dr. Wilson what he supposed to be the function of the ciliary muscle in the Seal's eye, or whether he considered that the Seal possessed a ciliary muscle at all.

The President said, the question was far from being merely an anatomical one. Anatomists had examined the eyes of animals with respect to the mechanism of accommodation, but seemed to have got no definite result, as far as he could understand. Opticians had also examined the eyes of animals with reference to the same question, without much result. None of them singly had arrived at results of much value. The true state of the case was to be arrived at by a combination of the researches of both. It appeared to him that the first difficulty about the question was, to settle a point which naturalists only can decide, namely, whether the Seal can see better in water or in air. The difficulty raised by Dr. Bennett is removed the moment we assume that the Seal sees better in water than in air. If it be assumed, on the contrary, that the animal sees best in air, opticians and anatomists must provide a mode of elongating his eye. If the Seal see best in water, there must be a power of accommodation in the eye, and it must be shortened when he comes into the air; and that hypothesis would fall in with Dr. Bennett's objection, that the action of the muscles would shorten the globe of the eye, and not elongate it. Whether the action of the muscles of the Seal's eye is to shorten or to elongate the globe must be decided by anatomists, but that will not interfere with the settlement of the point as to the nature of the accommodation in the Seal's eye. The great interest attaching to the problem as to the eye of that animal, more than that of any other, depends upon the fact, as admitted by naturalists, that he sees very well in air, and also very well in water. He will dip at the flash of a gun before the bullet can reach him; and it is equally certain that he must see well in water, because he can catch the salmon. Therefore, both opticians and anatomists must start from the hypothesis that he sees equally well in both elements. The change in refractive conditions that the animal must be capable of in passing from one of these elements to the other is something very remarkable. Anatomical inquirers speak at their ease about the lengthening of the Seal's eye, the changing of the cornea, and the alteration in the shape of the crystalline lens. He did not think they had considered the amount of change that the necessity of the case would require. He made some calculations himself, which he checked by a reference to the work published by a gentleman who was a much higher authority on the subject of optics than he was, namely, Dr. Lloyd, the Vice-Provost of Trinity College. In these calculations he had no data taken from the eye of a Seal, and was obliged to take those supplied by the human eye. The depth of the human eye from the front of the cornea to the retina is 0·95 of an inch. Assuming that the accommodation of the human eye necessary for the purpose of vision in water is accomplished by the action of the recti muscles, the eye would have to be pulled out by those muscles from a diameter of less than an inch to 2·75 inches. That showed it to be physically impossible that the necessary change could be produced by the simple elongation of the chamber. The first mathematician who ever directed his attention to this curious and important question was Kepler. Modern researches have not added much to his investigation of the subject; and he asserted that the accommodation of the human eye must be due to one of the following causes:—1. Change in the cornea; 2. Lengthening or shortening of the eye; 3. Change in the position of the crystalline lens; 4. Change in the shape of the crystalline lens. Kepler himself decided, so far as the human eye was concerned, in favour of the solution which derives the power of change from the position of the crystalline lens. Mr. Wilson had directed attention to the fact that there was a zone of minimum strength in the eye of the Seal. Whether the effect of that zone is, as Mr. Wilson states, to elongate the eye when the recti muscles press upon it, or to shorten it, as Dr. Bennett thinks, is a matter of indifference; for it resolves itself into a question of whether the Seal's eye is accommodated from water to air by the shortening of the globe, or from air to water by the lengthening of it. The aqueous and the vitreous humours are so nearly coincident in refractive power with the water in which the Seal lives, that practically his eye when he dives may be considered as reduced to its crystalline lens only. Applying that assumption to the human eye, Dr. Lloyd has calculated that a man, in order to see clearly in water, would require to wear double convex spectacles of crown glass, having a radius of one-third of an inch both ways. The amount of alteration, therefore, necessary for the change from air to water, was so enormous as to render it indispensable that whatever solution of the question was to be accepted should be decisively made out. Kepler's first solution explains nothing, for no change in the shape of the cornea under water would alter the phenomena. The fact that an elongation of the eye from one inch to two inches and three-quarters was physically impossible excluded his second solution; therefore the third and fourth, as to the position or the shape of the crystalline lens, only remained. As long as we confine ourselves to the human eye, Kepler's solution, by the shifting backwards and forwards of the crystalline lens, is not to be disputed. He shows that a very small change in the position of that lens along a line directed to and from the object would be sufficient. But this explanation will not answer for animals changing from water to air. Nothing is left, then, for their case, but the fourth supposition, that of the change in the shape of the crystalline lens. Even this must take place on a far greater and more important scale than anatomists have as yet suspected. The change amounts to the addition of a double convex lens of crown glass, having a radius of a third of an inch; while the elongation principle would require the lengthening of the chamber from one inch to two inches and three-quarters. Anatomists have not as yet discovered a mechanism for changing the shape of the lens sufficient to produce those results. The lens should be almost turned into a sphere; and he knew of no ciliary muscles capable of effecting so great a change.

Captain Hutton suggested that the pressure of muscles upon the lenses of the eye might, perhaps, alter the density and refractive powers of the humours inside the lenses.

Mr. Lalor observed that, in his experience, when a person dives under water, the eyelids open out. The deeper one goes the less light is there in the water. Pebbles and other small objects at the bottom, which appear magnified near the surface, diminish in apparent size when the bottom is approached; consequently, when the Seal dives after his prey, his eyes need not alter, he thought, because the deeper he goes after the objects of which he is in pursuit, the smaller they become; and he would require great visionary power if he were to dive much deeper than a man can.

Mr. Wilson, in reply, said he believed the Seal's eye to be specially adapted for the water. The animal took its prey in the water, and therefore must be able to see best in that element. As to the density of the lenses of his eye, he believed their refractive power to be altered by the muscles, viz., the ciliary, assisted by the recti and other external muscles; and he observed, that in the specimen of the Seal's eye, when it was freshly removed from the head, the ciliary muscle was extremely small. He submitted it to Dr. Robert M'Donnell, who discovered no voluntary muscular fibre in it. In the specimen in spirits, the ciliary muscle and space were very large.

IX.—ON ORCHIS MASCULA WITH DOUBLE FLOWERS. By DAVID MOORE, PH. D.

[Read before the Royal Dublin Society, May 15, 1865.]

IN the October number of "Seemann's Journal of Botany" for 1864, I noticed the discovery of *Orchis pyramidalis* with double flowers in the county of Clare, by F. G. Foot, Esq., and described the changes which appeared to me to have taken place in the parts of the flower to render it double. That being the first instance on record of the species having been found in that state, it was looked on with considerable interest by botanists.

Dr. Masters, of London, again noticed the matter in the number of the same work for December, and gave farther details of the changes which took place in the parts of the flower.

Another interesting instance of one of our native species of Orchis has just been sent to me this morning from the Bridge of Allan by Dr. Patterson, one of the resident physicians there. It is an early *Orchis mascula*, and the first time I believe it to have been ever seen with double flowers. Happily, the parts are so large, that the nature of the morphological changes which have taken place can be well studied.

Moquin-Tandon, in his "Elements de Teratalogie," classifies the prolifications which take place in causing double flowers as *median*, *axillary*, and *lateral*:—*Median*, when the centre of the flower is changed and prolonged beyond its usual state, and leaving other buds, as frequently occurs in the rose; *axillary*, when the prolification springs from the axil of one of the parts of the flower; and *lateral*, when the addition is rather to the inflorescence than to the flower itself. The remarkable changes which have taken place in the flowers of this Orchis appear to embrace two of these terms—*median* and *axillary*.

The flowers are reversed on the rachis of the axis which bears them, the labellum being next the apex, in place of the sepals being uppermost, which is the normal state of the flower. The changes of the parts are very curious and interesting. On the sides of the labellum are two smaller labella with short spurs, and in the axils of these other flowers spring, thus rendering the morphology *axillary*. These secondary florets have, again, rudimentary florets in the axils of their changed labella. There is no ovary, or column, or nectary distinct, though in some instances in the secondary flower they are apparently present in a very rudimentary state. The part where the column ought to be in the general flower is a mass of bracts and incipient florets, forming a depressed raceme—thus showing the prolification to be *median* also.

The malformed parts in the incipient flowers do not appear to exceed the usual number of pieces in the regular flower of Orchis.

This is supposed to be the second instance of *median* prolification in forming the double flower of an Orchis, the first being that already noticed by Dr. Masters, relative to Mr. Foot's *Orchis pyramidalis*, which I sent to "Seemann's Journal of Botany."

I have now another remarkable instance of duplication in an Orchid flower, though caused in a very different manner from that of the former. It is the beautiful *Calanthe veratrifolia*, a tropical species. The alteration in this instance has occurred by the blending of three flowers into one, and is only partial on the raceme. The three flowers are attached to one solid peduncle, which springs from the rachis between two bracts, in place of one, which is the normal condition of the flowers. Each has its proper labellum, column, and pollen masses; but there are only ten pieces of sepals and petals, in place of fifteen, which would have been the case had the flowers been separate and normal. The spur on the middle flower is wanting, and in place of it are two petaloid pieces with green tips.

It is further worthy of notice, that the flower on the rachis, which is immediately under the malformed one described, is without a labellum altogether.

X.—On an Approximate Method, founded on Observation, of Determining the Daily Excretion of Urea in Health and Disease. By the Rev. Samuel Haughton, M. D., F. R. S., Fellow of Trinity College, Dublin.

[Read before the Royal Irish Academy, June 27, 1864.]

The researches of chemists and physiologists, in recent times, have demonstrated that all the nitrogen received by the body in food is eliminated by the kidneys; and that the supposition that the skin or lungs contribute, except in very small proportions, to this elimination, is erroneous. This important fact, based upon very accurate experiments, would seem to render more necessary than it is considered usually to be the determination of the amount of Urea excreted in health and disease.

To find the Urea in a given liquid, requires a combination of qualities and circumstances that can only rarely occur to the practical physician.

1. He must be a good chemist.
2. He must have a chemical laboratory at his disposal.
3. He must have thirty-five minutes to spare on each case in which he determines the Urea by Liebig's nitrate of mercury process.

These conditions, the coexistence of which in practice is impossible, have prevented practising physicians in modern times from paying that minute attention to the urine of their patients that was customary in the earliest times of medicine.

In the accompanying Table, which is founded on many observa of urine, both of health and disease, of specific gravities from 100 1028, I have given what I believe will prove a very useful approx tion to the daily excretion of Urea in all cases in which sugar is ab and albumen either absent, or only present in small quantities.

The Table is one of double entry, to be used in finding the daily cretions of urine in fluid ounces, and its specific gravity determine a carefully graduated urinometer.

I submit it with confidence to the test of practical experience, have so often tested it myself in fever, in pneumonia, in dyspepsia, in kidney diseases, that I believe it will be found a most valuable a the physician, both in the prognosis and in the treatment of these other diseases.

XI.—Notes on Crannoges in Ballin Lough. By G. Henry Kina

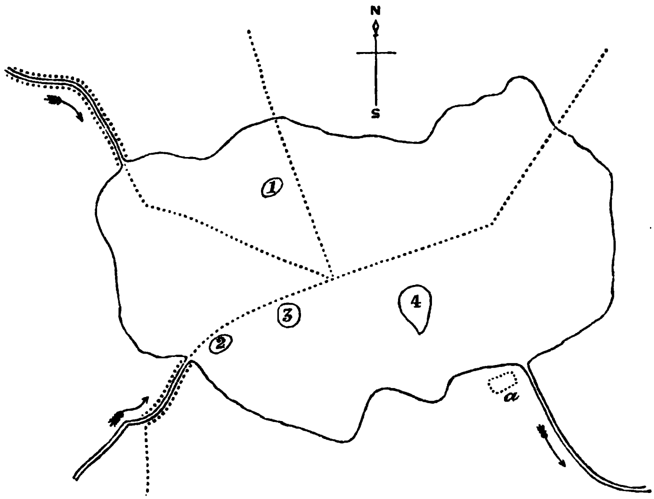
F. R. G. S. I., Senior Geologist of the Geological Survey of Irelan

[Read before the Royal Irish Academy, November 30, 1864.]

Ballin Lough is situated in the parish of Ballinakill, barony Leitrim, county of Galway, Sheet 125, and on the junction of Sh 116 and 125 of the Ordnance Inch Map of Ireland. It lies a little than half a mile south-east of Marble Hill, the seat of Sir T. J. Bu Bart.

BALLIN LOUGH (COPIED FROM THE ORDNANCE SIX-INCH MAP).

Fig. 1.



In this lough are four islands; and, as they have no local names, shall call them in these Notes as follows:—No. 1, or *North Islan*

N GRA

PECIFIC

1015
142
149
156
163
170
177
184
191
198
205
213
220
227
234
241

PECIFIC GRAVITIE

1015	1016	1026	1027	1028	
142	151	278	279	280	**20**
149	158	292	292	294	21
156	166	305	306	308	22
163	173	319	320	322	23
170	181	333	334	336	24
177	188	347	348	350	**25**
184	196	360	362	364	26
191	213	374	376	378	27
198	221	388	390	392	28
205	228	402	404	406	29
213	226	416	418	420	**30**
220	233	429	432	434	31
227	241	443	446	448	32
234	249	457	460	462	33
241	256	471	474	476	34
		485	488	490	**35**

No. 2, or *West Island;* No. 3, or *Middle Island;* and No. 4, or *East Island*. (See Figs. Nos. 1 and 2.)

Through the kindness of J. Hemsworth, Esq., of Danesfort, who placed his boat and man at my disposal, I was enabled to examine them during March, 1864, and found that Nos. 2 and 3 are Crannoges, or artificial islands, while No. 4 may be one.

No. 1, *or North Island.*—This, by the Ordnance Survey Map, is about 280 feet from the north shore; but during the dry season it can be approached by a peaty, reedy bank which runs from it towards the N.-E. It is of a rude oval shape, the diameters being twenty-five and sixteen yards long. When visited, it was about a foot above the surface of the water, and we excavated for over four feet in depth through peat without finding any traces of ancient occupiers; and as there are no stones round the outside of it, we came to the conclusion that it was not artificial.

No. 2, *or West Island.*—This lies about 80 feet from the shore, to which it is joined during the dry season. It is of a rude oval shape, the diameters being about 33 and 15 yards; the outside is regularly covered with flat stones. Most of it was covered with water when it was visited; we therefore excavated in the centre, where we found—

Section No. 1.

		Ft.	In.
Bog and clay, with a few bones, ...		2	0
Wood ashes, full of pieces of charred bones, .	over,	1	6
		3	6

No. 3, *or Middle Island.*—This lies about 500 feet from the nearest shore, and 250 feet from the West Island. It is nearly round, and about 32 yards in diameter. Outside it, for a width of about four yards, there are regularly placed flat stones; and we were informed by the fishermen of the lake that during the summer, when the water is low, piles can be seen all round it; but, as the water was high at the time of our visit, they could not be seen.

On account of the height of the water and the porous nature of the materials forming the island, we could not make a careful examination; but near the west shore, where the island was a foot above the surface of the water, we made a small excavation, and found—

Section No. 2.

		Ft.	In.
6. Peat and clay, ...	about	0	9
5. Peat and stones, with a few bones, ...	„	0	9
4. Wood ashes and peat, with thousands of unbroken cherry-stones, a few broken hazel nuts, a few broken bones, teeth, and a ball of red colouring matter, . . .	„	2	6
3. Basket floor, about one and a half inches thick, . .	„		
2. Sawn oak beams, 8 by 6 inches, ...	„	0	6
1. Peat, ...	over	0	6
		5	0

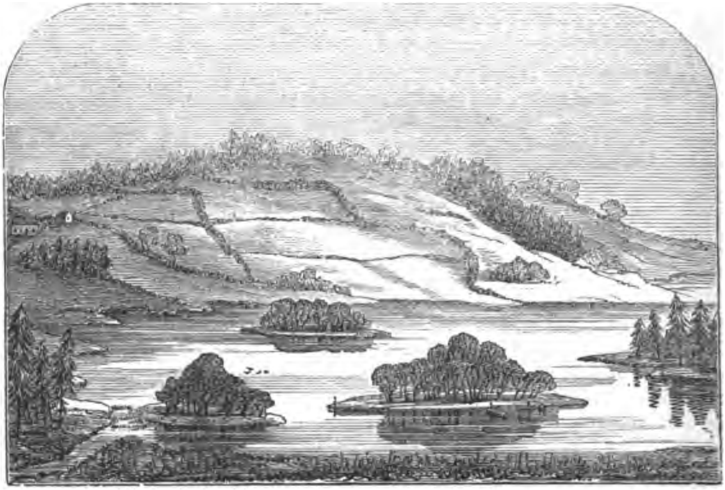
The oak beams (No. 2, section 2) were evidently sawn, not cut with a chopping instrument. Through them, at about nine inches apart, there were pairs of dowels that were used to fasten the basket flooring to them; these beams seem to run nearly N. and S.

In the basket flooring, at about every nine inches, were poles, 2·5 inches thick, through which the previously mentioned dowels went, and fastened the flooring to the beams. These poles seemed to be ash saplings, while the rest of the flooring was made of hazel rods. Below the beams there was peat, but it could not be examined on account of the quantity of water that rushed into the working. This Crannoge seems to have been divided into huts or apartments, as part of a row of ash piles, three inches in diameter, was observed.

No stone or other implements were found, nor was it likely that there should, as only a small opening was made, and only a few feet of the basket flooring uncovered. To find them, the Crannoge ought to be carefully explored during the summer, when the water would allow the bed lying on the flooring to be cleared out.

SKETCH OF BALLIN LOUGH, LOOKING N. E.

Fig. 2.



The island in the middle distance is No. 1, or North Island; that on the left hand, over which there are birds, is No. 2, or West Island; the island on the shore of which a boat is seen, is No. 3, or Middle Island; and a small portion of No. 4, or East Island, is seen at the right-hand margin of the sketch.

No. 4, *or East Island.*—This lies about 300 feet from the south shore, and is of an irregular pear shape, being about sixty-seven yards in length from north to south, and fifty yards in its widest part from east to west. Round outside this island for about four yards in width there are regularly placed small flat stones; and at the S.-E. shore of the island (under the water at the time we visited it), there is an east and west beam seven inches wide. These things would seem to point to its being artificial; but we made various excavations in different parts of the island, and found no traces of ancient inhabitants; an excavation in the centre of it gave us four feet of peat, under which was shell marl. From this I am inclined to think that this island may have been partly natural, and partly artificial.

Ballin Lough occupies a hollow among low hills, the only exit from it being on the S.-E., at the village of Ballinlough, where there is an artificial cut about four feet deep through a bank of coarse stony drift (*boulder clay*), about sixty yards wide. If this cut was filled up, the waters of the lake would rise at least four feet higher than at present; and that the water was at this level not long since, would seem to have been the case, as all round the lake to over that height there is a deposit of shell marl and peat. As the level of the water when the island was examined was three feet above the basket floor in the Crannoge, it must have been at least seven feet above the floor before the cut was made through the bank of drift. From this we see that when the Crannoges were built, the water of the lake must have been at least four feet lower than in March, 1864, and at least eight feet lower than the height of the water before the artificial cut was made; how the waters could have been at that level we have now to consider.

On the Ordnance Maps we find that the height of the lake is 356 feet above their datum level, and that a quarter of a mile to the S.-E., in the townland of Tulla, the surface of the stream is 340 feet. From this we see that if a cut was made from this point, it would lower the lake sixteen feet; or thirteen feet lower than the basket flooring of the Crannoge; and if we examine the stream, we will find that the rise from this point to the village of Ballinlough is only a few feet, while from the village to the lough it is very rapid, being over eight feet. From this we see that if there had once been a natural cut or ravine through this bank of drift from the village to the lake, the waters of the latter would have been five feet below the basket flooring of the Crannoge. On examining the bank of drift on the west of the village, what may be the trace of an ancient ravine will be observed, which appears to have been *artificially filled up* with stuff taken from an oblong excavation, marked *a* on Fig. No. 1, about three or four yards wide, and about six or eight yards long, and that the ravine since it was filled up has been used as a road, which has helped to obliterate the old embouchement of the lake. To account for this artificial filling, I would suggest that the inhabitants of the Crannoge were flooded out by an enemy who stopped the egress of the lake, and thus raised the waters until the islands with the huts and inhabitants were swamped. The islands after this were submerged until the present cut was opened, when they again appeared. In latter years they have been occupied by various individuals, generally for illicit distillation.

In the lake the horns and skulls of the Red Deer have been discovered at various times, and the head and horns of the Irish Elk are also said to have been found; but for the latter there is no good evidence.

I should be inclined to consider that these Crannoges are not as old as those which I previously described as occurring in Lough Rea; for in the Lough Rea Crannoges the piles and beams all appear to have been split, while in the Ballin Lough Crannoge the beams were undoubtedly cut with a saw. That there was an ancient settlement hereabout, and that it was a plaçe of note, seems to be proved by all the ancient remains scattered about, which will be seen on looking at the Ordnance Map (*Galway Sheet*, 125), as within a mile of the lake are thirteen Raths and Raheens, eight Cromlechs, and one Holy Well (Tobermacduagh). All the Cromlechs and the Holy Well lie to the N.-W. in Marble Hill Demesne, the ancient name of which was Gortenacuppoge, *i. e.*, "The Field of the Leaves;" and most of the Raths and Raheens lie to the N. and N.-E., only three (which are Raheens) on the south.

At a more recent period it would appear that this neighbourhood was still a place of note, as about three miles to the north-east there are the ruins of an extensive abbey and castle, and a mile on the north are the ruins of a church and castle. The abbey may have been founded by St. Colman M'Duagh, as the Holy Well previously mentioned is dedicated to him.

I may here mention that Sir W. Wilde, in his list of recorded Crannoges in the Catalogue of the Royal Irish Academy, says:—"Even so late as 1610 we read of Crannagh Mac Knavin, in the parish of Tynagh, barony of Leitrim, and county of Galway." I could find no trace of this Crannoge; but I imagine its site must lie somewhere in the large alluvial flat and bog which occupies the country south and south-west of Crannagh, the seat of R. Nugent, Esq., which is in the parish of Tynagh, and barony of Leitrim, and lies about half-way between Portumna and Marble Hill. It is remarkable that, although it was inhabited up to so late a period, and that the descendants of the sept of the Mac Knavins still live thereabouts, I could find no tradition about it in the neighbourhood, and the only trace the name of Mr. Nugent's place. These flats and bogs, somewhere in which I suppose the site of this Crannoge to be, lie between four and five miles E.-N.-E. of Ballinlough, where are situated the Crannoges which the Notes just read refer to.

XII.—NOTES ON A CRANNOGE IN LOUGH NAHINCH. By H. B. TRENCH, ESQ., and G. H. KINAHAN, F. R. G. S. I.

[Read before the Royal Irish Academy, January 26, 1864.]

LOUGH NAHINCH, i. e. *The Lake of the Island*, lies on the junction of Tipperary and the King's County, the Crannoge being situated in the former, barony of Lower Ormond, parish of Ballingarry, Sheet 11 of the Townland Survey of Tipperary, and Sheet 135 of the One-inch Ordnance Map of Ireland.

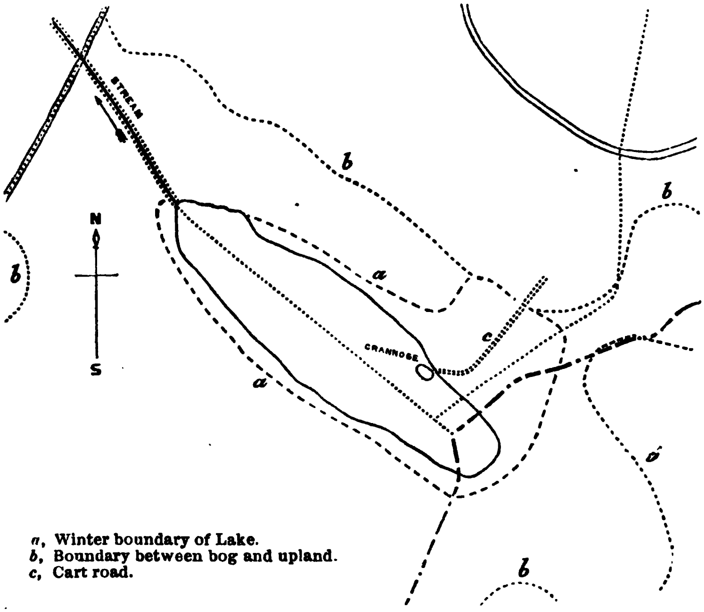
This lake lies in a large bog basin (*see Geological Map of Ireland, Sheet* 135 *and Map Fig. No.* 1), and was formerly much larger; but previous to the year 1812, its outlet to the N.-W. was lowered, and the land about it reclaimed. In winter its limits extend much farther than during the dry season, as the ground about it is low.

The appearance of the Crannoge has been much changed since the lake was lowered, as on its south shore a quay was built on which to land turf cut in the peat bog on the south, and many of the piles that surrounded the Crannoge have been removed, and its circular shape changed. Our attention was first directed to it by the following notice in Wakefield's "Ireland," which was published in 1812:—"In the highest part of this reclaimed land, which is about the middle of the old lake, there is seen a circular part, in shape the top of an immense tub, about sixty feet in diameter. The large planks which form the staves are from one to two feet broad, and about six inches thick, quite straight as far as it has yet been possible to trace them downwards. None of them have yet been raised without cutting them. At present there is no appearance of either ax or saw having been used in the formation of them."

When the island was visited in March and August, 1864, it was found to have shallow water all round it, except at the south, where the previously mentioned quay was built; on the east there is a track into the mainland (C *on Map Fig.* 1), that may also be of modern construction; at all events, it was used at the same time as the quay, and has been repaired from season to season, by laying branches and trunks of trees across it, and covering them with gravel. At the junction of this track with the quay at the S.-E. of the island, one of the old oak sheeting piles was remarked, the section of it being 4 x 12 inches. On the north of the island more of these piles were noted, forming part of a circle; and from them, running S. and S.-E., are two rows of round perpendicular ash piles, 2·5 inches in diameter, that appear to have been parts of two partitions or walls that divided up the space inside the circle of sheet piles into rooms or habitations. On the N.-W. of the island, about three yards from the present shore, are also some of the circle of sheet piles, and between them and the land are, E. and W., beams about four feet apart, and about four feet lower than the surface of the island. There are also above these, and close to the edge of the island, irregularly laid logs of oak, on an average about five inches in diameter, mingled with large stones. On the S.-W. of the island there is a set of oak sheet piles bounding the end of the quay; these seem to have been recently put here, and may have been some of those mentioned in the extract before quoted, "that were raised" when the quay was built, and were redriven here to protect the pier. There are also a few other piles, but they are evidently modern, being round fir sticks, which appear to have been used to fasten the boats to.

LOUGH NAHINCH.

Reduced $\frac{1}{5}$th from the Ordnance six-inch Map, equal to $4\frac{8}{10}$th inches to the mile.


STREAM
N
S
b
b
b
b
b
a
a
c
CRANNOGE
a, Winter boundary of Lake.
b, Boundary between bog and upland.
c, Cart road.

The difference between the level of the water of the lake in March and August was only about a foot, or a foot and a half; and the island is of such a porous nature, that the water rushed in everywhere, and prevented satisfactory work; but we opened small excavations in various places, and found the general section of the island to be:—

General Section.

			Ft.	In.
6.	Bog,	about	0	6
5.	Bog, ashes, bones, and nuts,	„	1	6
4.	Stones and large oak sticks irregularly laid,	„	0	6
3.	Peat, bones, and ashes, in which are oak beams lying in different directions,	„	1	6
2.	Nearly E. and W., oak beams, about four feet apart,	„	0	6
1.	Peat, wood chips, and bones,	over	1	0
			5	6

From this it is seen that the artificial work, measured from the present surface of the island, is more than 5·5 feet in thickness. On the beams (*Bed No. 2 in Section*) there seems to have been a basket flooring, but of this we could not be certain, on account of the depth of water in the excavation; but in connexion with them we observed *wicker walls*, made of hazel rods. Where the wicker walls cross the oak beams, there were round holes through the latter for the stakes to go through. In the vicinity of these beams a small rude stone implement made of Silurian grit was found, but it was so rotten, that it broke while the dirt was being removed from it.

The beams in bed No. 3 were charred on the under surface as if they had been the beams which supported the roof of an edifice that was destroyed by fire; near the north of the island, immediately over these charred beams, there was a N.-W. and S.-E. plank about ten feet long, twenty inches wide, and two inches thick; at about one foot nine inches from its N.-W. end there were two holes through it, four inches by two inches, that ran north and south in a line with the north and south piles seen on the north shore, and on each side of the plank were upright stakes ranging in the same direction. In bed No. 5, near the centre of the island, a large heap of wood ashes was found, and innumerable quantities of hazelnut shells and a few of walnuts. The bones found in the different beds seem to be those of pigs, sheep, and cows.

From the facts we were able to collect, we may draw the following conclusions:—That the base of the artificial work is more than 5·5 feet below the present surface of the island; that it was inhabited *at least* at two different periods, the first of these being when the east and west beams formed the floor of the habitations; those habitations seem to have been destroyed by fire, which would account for the charred beams. After this period the oak sticks and stones irregularly laid were placed to form a floor for new habitations. Between these periods we must suppose that the waters of the lake rose considerably.

Within a mile of Lough Nahinch we find that there are the remains of nine *raths* and *raheens* in the county of Tipperary, and five or six in the King's County; that there were more would seem likely, as the name of the townland on the south of the lake is Lissadonna, and yet there is now no trace of a *liss* or *rath* in it; and in other places raths are said to have been levelled with the ground. The old castle at Ballingarry lies about a mile N.-W. of the lake; it may have been built to prevent the natives from re-occupying their island home.

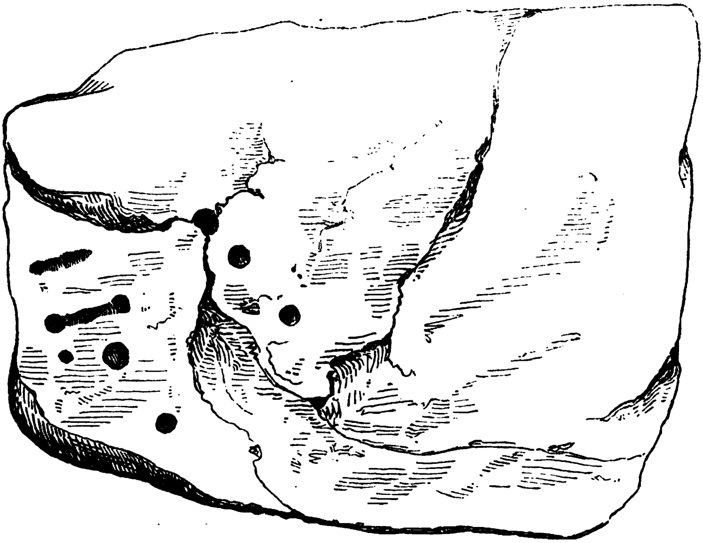
XIII.—On Inscribed Monuments in the County of Kerry. By the Very Rev. Dean Graves (lately discovered by himself and his son, Mr. Alfred Graves).

[Read before the Royal Irish Academy, November 30, 1864.]

The monuments now brought under the notice of the Academy appear to be nearly related to a class which formed the subject of a paper read by Dean Graves to the Academy in February, 1860. The monuments then described exhibited inscribed circles, or groups of concentric circles, having at the centre small cup-shaped hollows, of from two to four inches in diameter. The monuments to which attention is now directed present numbers of the cup-shaped hollows, unaccompanied by circles.

Five of them are the covering stones of large cromlechs, and Dean Graves thinks that there is reason to believe that the hollows were designedly arranged in certain alignments. The monuments, however, have been so much defaced by the action of the weather during hundreds, perhaps thousands of years, that it is hardly safe as yet to insist positively upon this point.

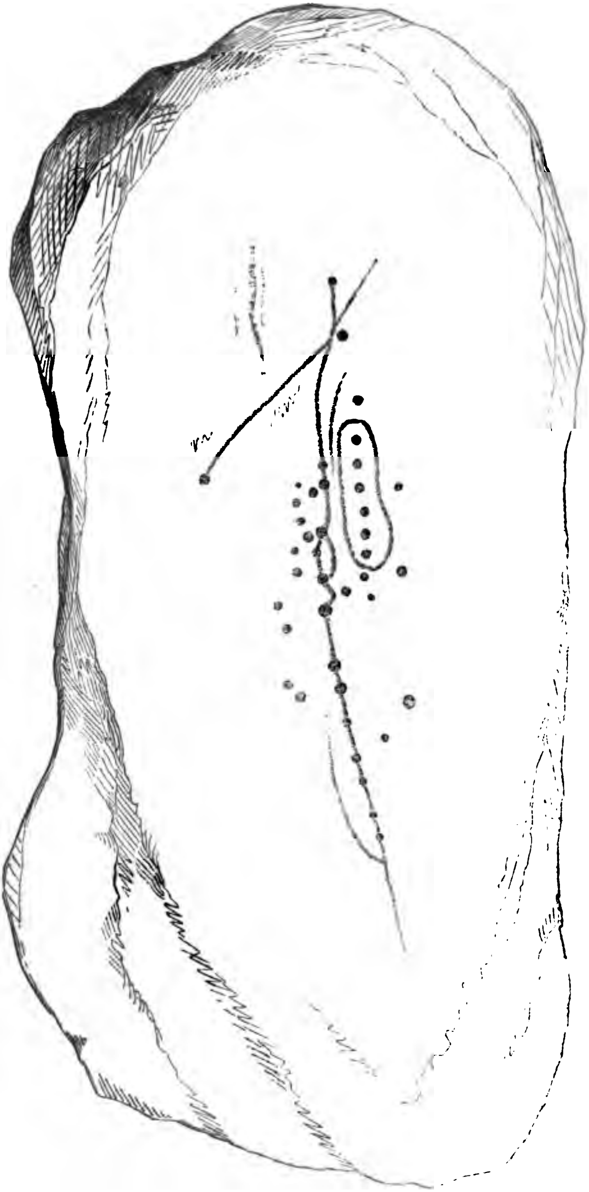
Dean Graves remarks that the occurrence of these symbols on what are undoubtedly sepulchral monuments may help towards the discovery of their signification. A huge block, found by Mr. Alfred Graves, at Loher, near Darrynane, and exhibiting some of these hollows, serves as the covering stone to a sepulchral chamber excavated in the earth under it; a narrow covered gallery, of twenty-four feet in length, constructed in the ordinary way, leads to the subterraneous chamber. Though careful search was made in it for human or other remains, nothing was found, with the exception of a few fragments of charcoal, and a portion of a charred bone.



Scale, $\frac{2}{10}$th of an inch to 1 foot.

The other monuments described in Dean Graves's paper were found in the following localities:—One in the island of Valencia; another, near Cahirciveen; a third, near Waterville bridge; and two more, near Sneem.

The Dean concluded by expressing his expectation that artificial hollows would be found on many of the covering stones of cromlechs on which they have not been yet observed, simply because their existence was not suspected. Where the surface has been much affected by the weather, any hollows that appear may be readily mistaken for natural ones; but hollows that are certainly artificial having once been recognised, the eye of the antiquary will be prepared to observe those which are not so obviously the work of man.



Scale, about $\frac{7}{20}$th of an inch to 1 foot.

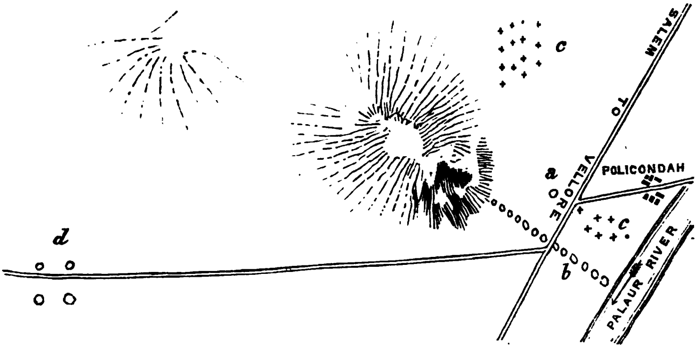
Dean Graves noticed some other monuments in Kerry which exhibit circular hollows, but do not admit of being classed along with those described in this paper.

XIV.—On a Cromlech and other Ancient Remains in the Presidency of Madras. By Henry O'Hara, Esq.

[Read before the Royal Irish Academy, December 12, 1864.

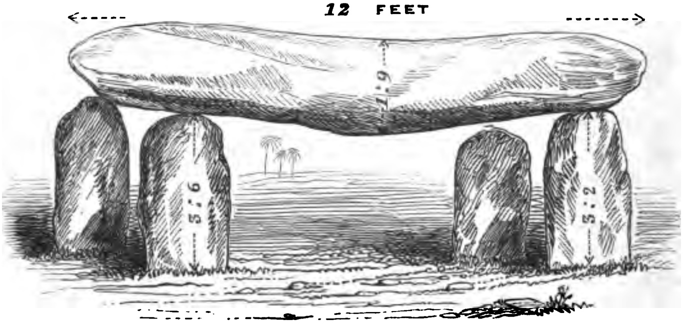
"Very Rev. Sir,—It may interest the Members of the Royal Irish Academy to know that in the Madras Presidency, East Indies, Cromlechs such as are found in Ireland are met with.

Fig. 1.



"I enclose a rough pen-and-ink sketch of one standing some short distance from the Travellers' Bungalow at Policondah, thirteen miles from Vellore. The ground in this locality is covered with interesting relics of a race whose occupancy of the country was evidently anterior to the Hindoos. I have marked on the sketch a line of defence from the base of the hill to the river, composed of large boulders. The foun-

Fig. 2.



dations of circular buildings exist in considerable numbers; and at the entrance to nearly all the dwellings a mass of granite stands, with a cavity cut into its upper surface, evidently intended for a mortar to pound grain in.

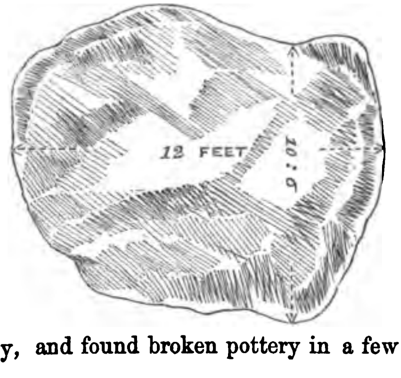
"The Cromlech I send a sketch of must have been an altar for sacrifice; it stands on a mass of laminated gneiss that crops out on the surface, so that it could not have been intended as a place of burial. I have not sketched in the circle of stones surrounding the Cromlech; these are placed about a yard apart from each other, and form a circle of thirty yards diameter.

"While laying out a new line of road to connect the southern trunk road with that from Vellore to Amer, I discovered four other Cromlechs, placed so as to form a perfect square; they are similar in construction to the one sketched.

"The nature of my duties in India as an engineer in the service of Government took me much among the people, whose language and peculiarities I am well acquainted with. When I could prevail on one of the inhabitants near the site of these remains of a bygone race to get rid of the characteristic apathy of his countrymen to matters not personally interesting, I could learn from him the tradition, 'that the stones were put up by a people who lived in the country before Buddhism or Brahminism was introduced, and that the Cromlechs were sacrificial altars on which men were immolated.'

"The villages of Dooshu and Mannidoor are a few miles south of the Palaar River, in the North Arcot District; between these villages an immense tank, or reservoir, for storing water for rice irrigation stands. The tank is formed by filling up the gorge between two low hills, and the water supplied by a channel from the river some miles higher up, and the drainage of the country. A large slab of granite has an inscription cut on it, and placed on the upper level of the tank; the character of the letters is the same as the present language of the country (Tamil) is written in, but the language of the inscription cannot be made out. This may be taken as a voucher for the antiquity of the tank; but the vast number of kistvaens that are to be found on the two low hills before mentioned, from their summits to base on all sides exposed to view, prove these hills to have been used as a burial ground long before the tank was constructed. I opened several of these monuments of antiquity, and found broken pottery in a few of them.

Fig 3.



"The tradition of the people here also is the same,—'that the stones were placed to mark where the people that preceded them buried their dead.'

"I will not attempt any conjecture as to the purpose for which the Cromlechs were set up; I submit the fact of their existence to you and the members of the Royal Irish Academy.

"Apologizing for the liberty I have taken in addressing you,

"I beg to remain, Very Rev. Sir,
"Your obedient servant,
"HENRY O'HARA, M. I. C. E. I.,
"Deputy Commissary, Retired List, H. M. Indian Army.

"*Fermoy, Co. Cork, Nov.* 25, 1864."

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XV.—NOTES ON SOME OF THE BIRDS INHABITING THE SOUTHERN OCEAN, By CAPTAIN F. W. HUTTON, 23rd Royal Welsh Fusileers, F. G. S.

[Read before the Natural History Society of Dublin, March 3, 1865.]

THE notes that I have the honour to read to the Society this evening are compiled from personal observations made during seven voyages round the Cape of Good Hope, at various times of the year, and from information obtained from my friend, Mr. Richard Harris, R. N., who was engineer on board Her Majesty's ship "Adventure," in 1857, in which ship I made my last voyage.

Mr. Harris sailed from London early in June, 1832, with a sealing party, and arrived at the Prince Edward Islands, in the Southern Ocean, in September, and stopped there until the following January, when they left for Kerguelen's Land, or Desolation, as the sealers call it. They reached this latter place at the end of January; and on the 16th of March, while they were on shore, engaged in sealing, their ship was wrecked, and they remained on the island until the 6th of December, when they made the bold experiment of sailing in a boat, built from the remains of their ship, for Tasmania, and happily reached Macquarrie Harbour in safety after a voyage of six weeks. While Mr. Harris was on these little-known islands he made many careful observations of the habits of the birds that frequent them during the breeding season, which he kindly communicated to me, and which, although made so long ago, will not, I trust, be found without interest. Most of these birds have been admirably figured and described by Mr. J. Gould in his "Birds of Australia." I have therefore confined myself to mentioning only those peculiarities of plumage and habits which are either new or still disputed points.

Before commencing, however, I wish to thank Dr. Sclater, Dr. G. Gray, Dr. E. Perceval Wright, and more especially Dr. A. Carte, and Mr. Gould, for the kind way in which they have answered my numerous questions on many of the points touched upon in this paper.

Chionis minor (Hartlaub)—Lesser Sheathbill.—This bird is common on both the Prince Edward Islands and Kerguelen's Land, and is called "wide-awake" by the sealers. When Mr. Harris first landed, the birds were so tame that he frequently had to kick them out of his way; and when he hid himself behind the rocks, they would come and peep over at him, chattering, and seeming quite pleased at having found him. They are always found near the sea, but do not fly much, only from one rock to another, and never leave the land. Mr. Harris never saw the nest or eggs of this bird, and therefore supposes that they breed in some place out of sight, either under the rocks along the shore, or in the high moss and grass, like the Skua Gull.

Lestris catarrhactes (L.)—Skua Gull.—This bird is the "Cape Hen" of sealers, and the "Port Egmont Hen" of Captain Cook. It does not skim over the water like the Petrels, but flies low, with a heavy slow flapping of its roundish-looking wings, and is therefore easily recognised. It is rare at sea north of lat. 45° S., one individual only having come under my personal observation. It is, however, very numerous on the Prince Edward Islands, and Kerguelen's Land, where it breeds on the low flats, among moss and grass two or three feet high, making no nest, but laying three brown dark-spotted eggs on the ground. The young birds are dark brown, mottled with white. During the breeding season the old birds are very fierce, flying round the head of an intruder, dashing every now and then at him, and making at the same time a curious croaking noise in their throats. Mr. Harris has never seen one chasing another bird.

Diomedea exulans (L.)—Wandering Albatross.—Average breadth across the wings, 10 feet—the smallest measured being 9 feet, and the largest 12 feet; length from tip of beak to end of tail, 4 feet. Some have a rose-coloured streak on each side of the neck, as mentioned by Dr. Bennett in his "Gatherings of a Naturalist in Australia." I have never seen this on either the young or very old birds; and the only one I ever captured with it was a male. I have also only seen these marks between June and August, and I am therefore disposed to believe that they distinguish the middle-aged male bird previous to the breeding season; but I am not sure of this. According to the experience of myself and Dr. Bennett, the food of the Albatross consists entirely of the oceanic mollusca, small crustaceans, medusæ, and the refuse thrown overboard from ships. I have never found any remains of fish in its stomach; and indeed I do not see how it could catch them; for it never pounces suddenly, like a Frigate Bird or a Gannet, on anything floating in the water, but always settles first, and then devours it at its leisure; in fact, it sits down to dinner. For this reason it can only be caught with a hook when the ship is going slowly—not more than four or five knots—and when plenty of line can be paid out, so as to give the bird time to look at the bait before he swallows it. The best bait is a piece of the rind of raw salt pork, as this is so tough that the small birds cannot get it off the hook. The hook need not be barbed, as it always catches in the curved end of the upper mandible; the bait must be floated by means of corks. I have never seen the Albatross fly at night, and its habits are quite diurnal, both at sea and on land. It is rarely found north of lat. 30° S.; but so constantly does it approach that limit, that I could generally predict the day on which we should see the first. In April, 1854, however, when sailing from Capetown to St. Helena, in about lat. 26° S., one flew past the ship in a direct line southwards, without even stopping to look at us; and I suspect that it had either been caught, and turned loose again after two or three days' imprisonment, or that it had followed a ship out of its usual haunts, and was now making the best of its way back again. They are very common south of latitude 40° S., and monopolize nearly the whole of the Prince Edward Islands, and the south-east portion, or lee side, as the sealers call it, of Kerguelen's Land, to which places they retire to breed in October.

The nest, which is always placed on high table lands, is in the shape of the frustum of a cone, with a slightly-hollowed top, and is made of grass and mud, which the birds obtain by digging a circular ditch, about two yards in diameter, and pushing the earth towards the centre, until it is about eighteen inches high. In this nest the female bird lays one white egg, which is not hatched until January. The nesting of the Albatross has been well described by Mr. Earle and Dr. M'Cormick; and I have mentioned it here only because Dr. Bree, who, in his "Birds of Europe," has given the latest account of this bird, has reproduced the statement of Captain Carmichael, in his "Description of the Island of Tristan d'Acunha," in the twelfth volume of the "Transactions of the Linnean Society," that it makes no nest—a statement which is certainly erroneous. At a certain time of the year, between February and June, Mr. Harris cannot exactly say when, the old birds leave their young, and go to sea, and do not return until the next October, when they arrive in large numbers. Each pair goes at once to its old nest; and, after a little fondling of the young one, who has remained on or near the nest the whole time, they turn it out, and prepare the nest for the next brood. The deserted young ones are in good condition, and very lively, frequently being seen off their nests exercising their wings. When the old birds return and take possession of their nest, the young one often remains outside, and nibbles at the head of the old one until the feathers between the beak and the eye are removed, and the skin made quite sore. The young birds do not go far from land until the following year, when they accompany the old ones to sea. While the old birds are away, it is difficult to imagine how the young ones obtain food; for Mr. Harris assures me that no old birds are seen near the islands for months together. Strange as this may appear, its very strangeness is in favour of its truth, as no one would think of inventing such a story; and its correctness is further corroborated by the abundance of Albatrosses found at sea from April to October, inclusive, and their comparative rarity, especially of the old white ones, during the rest of the year, which I believe to be the case. Of their abundance between April and October no one who has been in the Southern Ocean at that time of the year will doubt; and in the latter month I know from my own experience that the old birds begin to get scarce. It is more difficult to collect sufficient evidence of their rarity from November to March, as few voyagers visit the regions they inhabit at this season of the year, and fewer still take notice of the birds. Dr. Pickering, however, who accompanied the United States' Exploring Expedition, under Commander (now Admiral) Wilkes, states that this bird was only occasionally seen in January, while it was much more common in April; and Captain Cook's experience seems to have been much the same. In October and November, 1772, Albatrosses, he says, were common. In December and January they were scarce, or entirely absent; and but few seem to have been seen by him until he reached New Zealand, except on the 10th of February, 1773, when he reports an abundance, but on that day he was within a few miles of the south-east part of Kerguelen's Land, where they breed. He did not again visit these regions until the middle of December, 1773, when he left New Zealand for the Pacific; and from this time until the following February, when he got too far north, he appears to have observed very few—most, if not all, being young birds. At the close of this year (1774) he doubled Cape Horn, but after November no mention is made of Albatrosses—except that they were seen in Staten Island in January—until March, 1775, when he says that some accompanied the ship every day until he got beyond their habitat. Sir James Ross, too, in his account of the voyage of the "Erebus" and "Terror" in 1839-43, never mentions Albatrosses between November and March, and I am therefore disposed to believe that the old birds go to sea in March or April, when the young ones are about three months old. Mr. A. Earle, in his "Narrative of Nine Months' Residence in the Island of Tristan d'Acunha," as quoted by Gould, says that he saw old Albatrosses "stalking about" their young in May; but as *D. exulans* can only just manage to get along on land by the help of its wings in a most awkward and ridiculous manner, which no one would think of dignifying by the term "stalking," I am of opinion that he mistook *D. melanophrys* for this bird. On his way out, Mr. Harris spent three weeks in August at Tristan d'Acunha, Nightingale Island, and Inaccessible Island, but never saw any Albatrosses during the whole time. Mr. Harris says that when the old birds return in October, he never saw them feed the young ones; and it is therefore evident that they must have some means of obtaining food for themselves. My impression is, that the young birds are nocturnal in their habits, and go down to the sea at night, returning to their nests in the morning.* The instinct, or whatever it may be called, which enables the Albatross, after wandering over thousands of miles of trackless ocean, to find its way back to its young one every October is most extraordinary. Mr. Harris says that he feels quite certain that the same birds visit their old nest, and use it again for the next brood. In this case the landmarks, which might guide the swallow in its migrations, are entirely wanting; and as the birds spread on all sides from their breeding places, and doubtless sometimes traverse the whole globe, the position of the sun, which is the only natural guide that man possesses, cannot avail them anything. The flight of the Albatross is truly majestic, as with outstretched motionless wings he sails over the surface of the sea; now rising high in the air; now with a bold sweep, and wings inclined at an angle with the horizon, descending until the tip of the lower one all but touches the crests of the waves as he skims over them. Suddenly he sees something floating on the water, and he prepares to alight; but how changed he now is from the noble bird but a moment before all grace and symmetry! He raises his wings, his head goes back, and his back goes in; down drop two enormous webbed feet, straddled out to their full extent, and, with a hoarse croak, between a raven and a sheep, he falls souse into the water. Here he is at home again, breasting the waves like a cork. Presently he stretches out his neck, and, with great exertion of his wings, runs along the top of the water for seventy or eighty yards, until, at last, having got sufficient impetus, he tucks up his legs, and is once more fairly launched in the air. It is, I presume, this necessity of running along the top of the water before he is able to ascend from it which has given rise to the fable—as I think I may call it, although still quoted by some of the best naturalists—of the Albatross being able to walk on the surface of the water with hardly any assistance from its wings, and that the noise of its tread may be heard at a great distance, which originated with Captain Weddell in his "Voyage towards the South Pole," in 1822–24. I have never seen this bird dive. When caught, and placed on deck, they are unable to stand, or to rise from it, unless a strong wind is blowing, but lie almost helpless on their breasts. After they have been on board a few minutes they generally, but not always, throw up a large quantity of oil. I have sometime sailed past an Albatross sitting on the water, and it has not got up to join the other birds flying round the ship, but remained on the water until out of sight—a thing I have never observed in any other of the Petrels. I have not seen Nuttall's original account of this bird; but, as quoted by Dr. Bree, in his "Birds of Europe," it seems nearly as full of errors as words. He has evidently confounded the North Pacific species, *D. brachyura*, with *D. exulans*, although they are quite distinct.

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* Mr. Harris does not agree to this. In a letter to me, dated H. M. S. "Medusa," March 19, 1865, he says, that "the fact that they would stand to exercise their wings shows that they had not yet got the proper use of them;" also that he "never saw them upon the wing until the return of the old ones;" and, further, that the situations occupied by some of them were such as to make it "impossible for them to get to the water except by flight."

Diomedea melanophrys (Temm.)—Black eye-browed Albatross.—Breadth across the wings, 7 feet; length, 3 feet. Mr. Gould says that there is no difference between the young and the old birds, except in the colour of the beak, but in this I cannot concur. According to my observations the head in the young is grey, which, as the bird grows older, becomes white—first on the cheeks, then, spreading to the top of the head, leaves a collar round the neck, which breaks first in front, and gradually spreads upwards until the whole is white. The beak remains dark blue for some time after the plumage has assumed the colours of the adult. The feet and legs of the young bird are light blue. I am unable to give any new information as to where this bird breeds, as it is never seen on the Prince Edward Islands nor Kerguelen's Land. Commander Snow, in his "Two Years' Cruise off Terra del Fuego," says that it breeds in the Falkland Isles, and describes its nest as similar to that of *D. exulans*, but not more than twelve inches high; and Captain Carmichael states that it breeds in Tristan d'Acunha. Mr. Gould says that it is more easily caught than *D. exulans*, but my experience is just the contrary. When on board, it stands pretty firm on its legs; and I have never seen it vomit oil, as most of the Petrels do. It dives sometimes, but does not appear to like doing so—generally preferring, when anything good to eat is under water, to let a Night Hawk (*P. hæsitata*) fish it up; then giving chase, and running along the top of the water, croaking, and with outstretched wings, it compels him to drop it, and then seizes it before it sinks again. This bird is called "Molly Hawk" by sailors. It is common round Cape Agulhas; and in August, 1857, I saw a large number in False Bay, and round Cape Hanglip. It is apparently quite diurnal in its habits, both at sea and near land. *D. chlororhynchos* (Lath.) differs from *D. melanophrys* only in the rather lighter tint of the mark over the eye, and in the colour of the beak; in size and habits it is precisely similar; and, as the beak of *D. culminata* (Gould) is just intermediate in colour between the two, I am of opinion that all three are but one species. I am aware that Captain Carmichael states that the nesting of the two is different; but as he has wrongly described the nesting of both the other species of Albatross, I cannot trust his account without further evidence. No one acquainted with these birds can read Latham's description of *D. chlororhynchos* without at once seeing that he is describing an immature bird.

Diomedea fuliginosa (Gmel.)—Sooty Albatross.—Some of these birds are grey on the back and head, with the exception of a broad black stripe round the beak, which gives the head something the look of a jackdaw's. I am unable to say whether these are young or very old birds; but as their legs and feet are yellow, I incline to the latter opinion. It breeds in the inaccessible cliffs of Kerguelen's Land and the Prince Edward Islands, and Mr. Harris was never able to get at a nest. It has an unpleasant habit of screeching at night, and is called "Pee-u" by the sealers. Sir J. Ross mentions that he saw young birds fully fledged, and, as he says, "ready to go to sea," in May, at Kerguelen's Land; and, as no mention is made of old birds, this species may have the same habit of deserting its young that *D. exulans* has. It is, however, so shy, that Mr. Harris made very few observations on its habits. The remarks of Mr. Gould, that this bird is very wary, and seldom caught, and that it alone of all the Petrels flies directly over the ship, are quite correct.

Procellaria gigantea (Gmel.)—Giant Petrel.—This bird breeds in the cliffs of the Prince Edward Islands and Kerguelen's Land, but the nests can be got at occasionally. The young are at first covered with a beautiful long light-grey down; when fledged they are dark brown, mottled with white. When a person approaches the nest, the old birds keep a short distance away, while the young ones squirt a horridly smelling oil out of their mouths to a distance of six or eight feet. It is very voracious, hovering over the sealers when engaged cutting up a seal, and devouring the carcase the moment it is left, a thing the Albatross never does. It is the "Mother Carey's Goose" of Cook, and the "Nelly" of sailors. It sometimes chases the "Night Hawk" (*P. hæsitata*), but

Mr. Harris has never seen it kill one. Whether or not it can catch a bird possessed apparently of powers of flight superior to its own is doubtful; but, supposing one killed, that it feeds only on its heart and liver, I cannot believe, although it is said to do so in the works of many first-rate ornithologists—a statement which seems to have been copied from Lord Macartney's "Embassy to China" in 1712, and since handed down from one naturalist to another as an heirloom.

Procellaria æquinoctialis (L.)—Black Petrel.—Black, with a white mark, generally crescent-shaped, but very variable, on each cheek; chin white; beak yellow, with a white tip; legs and feet black. As the plumage of the bird here described is intermediate between the *P. æquinoctialis* of Linnæus and the *P. conspicillata* of Gould, I agree with Dr. Gray in ranking them as one species only. It is not known on Prince Edward Islands, nor on Kerguelen's Land, and I have only seen it in the South Atlantic between lat. 26° south and lat. 35° south. Among sailors it rejoices in the name of "Stink Pot."

Procellaria hæsitata (Licht.)—Great Grey Petrel.—This bird combines the appearance of a Procellaria with some of the habits of a Puffinus. Its feathers fit very close, and have a glossy look. Like all other Petrels, it flies with its legs stretched straight out behind, and as in this bird they are rather long, they make the tail appear forked. Its cry is something like the bleating of a lamb. The young bird has been figured and described by Dr. Andrew Smith in his "Illustrations of South African Zoology," under the name of *Puffinus cinereus.* They are very common at sea from May to August, but retire to Kerguelen's Land and other places in September or October, to breed. Each pair burrows horizontally into wet peaty soil from two to eighteen feet. At the end of the hole they form a large chamber, and construct in the centre of it a nest similar, except in size, to that of the Albatross, in the hollowed top of which the female lays one white egg. They seldom leave their burrows in the daytime; and when one happens to do so, it is at once hunted by a Nelly, although no such jealousy exists at sea. From this habit of flying only by night it is called "Night Hawk" by the sealers. Mr. Harris's party, when wrecked on Kerguelen's Land, used to dig these birds out of their burrows, and eat them; and in order to save useless digging—for their spades were only made from the staves of old casks—they would hold one to the mouth of a hole, and make it cry out, when, if another was inside it would answer. Mr. Harris informs me that he never saw the Night Hawk on the Prince Edward Islands; but as his party was not then in want, they did not hunt for them, and they may therefore breed there also; for, as they conceal themselves by day, they might easily have remained unobserved. This bird is by far the best diver of all the sea-going Petrels. It seems even fond of it, and often remains under water for several minutes, when it comes up again shaking the water off its feathers like a dog. Sometimes I have seen it, as it flies past, poise itself for a moment in the air at a height of about twenty or twenty-five feet above the sea, and, shutting its wings, take a header into the water. It dives with its wings open, and uses them under the water much in the same manner as when flying.

Procellaria macroptera (Smith)—Long-winged Petrel.—This bird, when on the wing, looks very like a large Swift. It is not by any means common, and I have only seen it east of the Cape of Good Hope. It is not found on the Prince Edward Islands nor Kerguelen's Land.

Procellaria glacialoides (Smith)—Silvery Grey Petrel.—Back, wings, head, and tail ash-grey, with a rudely-shaped circular ring of black near the tip of each wing; rest of the body white. Not common, and not seen by me east of the Cape of Good Hope; not found on the Prince Edward Islands nor Kerguelen's Land. I presume that this is the bird figured by Gould, although neither he nor Dr. Smith mentions the dark mark on each wing.

Procellaria mollis (Gould).—Soft-plumaged Petrel.—Not found on the Prince Edward Islands, nor on Kerguelen's land. They fly well, with their wings a little bent back, like a Sandpiper. I think it probable that this bird will prove to be the young of *Procellaria Cookii* (Gray).

Daption Capensis (Lath.)—Pintado Petrel.—Across the wings three feet, length fifteen inches. When caught and brought on board ship, it throws up from its mouth, as soon as touched, a quantity of red, strong-smelling oil—not as a means of offence or defence, but simply from fright. Mr. Gould states that when irritated it ejects an oily fluid from its nostrils, but this I have never observed. They cannot rise from the deck, but run along with outstretched wings. Their cry is like the sound made by drawing a piece of iron across a large-toothed comb—cac, cac, cac-cac, cac, the third being pronounced the quickest. It is called "Cape Pigeon" by sailors. Curiously enough, although this bird is by far the commonest of all the Petrels, and is so distinct in plumage that no one can mistake it, yet its breeding place is, I believe, not known with certainty. In Gould's account of the bird I find—"It is said to breed in Tristan d'Acunha," but Captain Carmichael does not mention it. Darwin ("Zoology of the Voyage of the 'Beagle'") was informed that the sealers know of no other place where it resorts to breed but the island of South Georgia, and it certainly is not found on the Prince Edward Islands nor Kerguelen's Land. Sir J. Ross, however, mentions having seen flocks of young birds in January, 1841, in lat. 71° 50′ south, near South Victoria; and it seems, therefore, probable that they breed on islands in the Antarctic Ocean, far south of the homes of the Albatross. Latham says that they vary much in colour, but I have always been surprised at their great constancy; and, as I could detect no difference in them, I suppose that the young birds remain near their breeding places until they have attained the plumage of the adult. According to my experience their northern limit is lat. 27° south, but they sometimes follow a ship as far as 24° south, and one once followed the ship I was in as far as 17° south. On that day I saw Tropic Birds, Flying Fish, and a Cape Pigeon all together—a most unusual occurrence, the thermometer, however, was only 70° F. in the shade. These and other small birds are much more easily caught with a thread than with a hook. The *modus operandi* is as follows:—A small piece of wood, about an inch and a half long, is tied by its middle to a line of white thread or silk; this is put over the stern, and allowed to float out some thirty or forty yards. The birds, flying under the ship's stern, strike against the thread, and entangle their wings in it; they are then hauled gently on board. If the ship is going fast, the thread will not be strong enough to hold them; for if it is too thick, they will see and avoid it.

Prion vittatus (Cuv.)—Broad-billed Prion.—Across the wings two feet, length ten inches. They generally fly in flocks, with a sharp motion of the wings like a Snipe. I can confirm the remark of Captain (now Sir George) Grey, the present Governor of New Zealand, that it is never seen to sit on the water. It is called "Whale Bird" by sailors. According to Captain Carmichael, this bird breeds on Tristan d'Acunha. It is not found on the Prince Edward Islands nor Kerguelen's Land. Besides these birds, Mr. Harris says, that a few ducks were found on Kerguelen's Land, and that Penguins were common upon all the islands. A night or two after their ship was wrecked, they lit a fire upon the rocks, when, to their astonishment, a large quantity of Stormy Petrels flew into it, and others dashed themselves against the rocks on which the fire was lighted, although these birds were rarely seen in the day-time. This shows that these birds are nocturnal in their habits when near land: at sea, however, they are much more common in the day-time than at night, and I have never heard of one of them, or any other Petrel, flying into a ship's port with a light in it, although this is by no means uncommon with flying fish.

General Remarks.—The extraordinary number of oceanic birds found in the cold regions of the earth, in comparison with the small number found in the tropics, is a very remarkable fact, as it is exactly the reverse of what we see on land. It can, however, I think, be accounted for as follows:—The higher plants have to deoxidize large quantities of water and carbonic acid for the formation of the sugar, various kinds of oil, camphor, resin, &c., that they secrete; but this process absorbs an equally large amount of heat and light, which can only be supplied by the sun, consequently they must inhabit warm or temperate climates, and live on land, or at any rate must have the greater portion of their leaves exposed directly to the air; for water is such a powerful absorbent of heat rays, that a depth of a few inches only is enough to prevent nearly all those that reach the earth on a cloudless day from penetrating further. The lower plants, however, which have little to develope but cellulose and chlorophyll, require less light, and but little heat; they are thus enabled to live under water, and in regions where the more highly organized forms would die, and, being unopposed, they increase here in number and dimensions far more than in warmer latitudes or on land; and as water maintains a more equable temperature than land, it follows that in cold regions the sea supports nearly the whole of the vegetation. This entails an equally large population of the lower marine animals, which subsist on the vegetation, and in their turn supply food to the Petrels, which, carrying about with them in their lungs an apparatus for producing heat, are not under the same necessity as the higher plants of living only in warm climates; and as the heat in summer is much less in the southern hemisphere than in equal latitudes in the northern, the marine plants, and consequently the Petrels, approach much nearer the Equator in the Antarctic than in the Arctic seas.

But, although the number of individuals is immense, the species are few, which is, doubtless, owing to the uniformity of the conditions under which they live.

It is very curious to note that most of the species of the *Procellaridæ* inhabiting the northern hemisphere have "analogues," or closely resembling species, in the southern hemisphere. For instance, the Albatross of the North Pacific Ocean, *D. Brachyura* (Temm.), very closely resembles *D. exulans* (L.), although it is undoubtedly distinct from it. *Procellaria glacialis* (L.), and *Procellaria pacifica* (Audub.), again, are nearly related to *Procellaria glacialoides* (Smith); *Puffinus cinereus* (Gmel.), and *Puffinus major* (Faber), to *Procellaria hæsitata* (Licht.); *Puffinus Anglorum* (Temm.), and *Puffinus obscurus* (Gmel.), to *Puffinus assimilis* (Gould); and the Stormy Petrels of the northern seas, with the exception of *Thalassidroma Leachii* (Temm.), differ from those of the southern seas only in some minor points of plumage, *Thalassidroma oceanica* (Kuhl.) being, as far as I know, the only Petrel common to both hemispheres. But, while most of the northern Petrels have representative species in the southern hemisphere, many of the southern ones find no analogue in the northern hemisphere—*e. g.*, *P. gigantea* (Gmel.); *Daption Capensis* (Lath.); *Prion vittatus* (Cuv.), *Pelecanoides urinatrix* (Cuv.), &c. These facts make it appear probable that the northern species crossed over the Equator from the southern hemisphere, perhaps during the glacial period, and, having been isolated ever since, have varied somewhat from the parent forms; and the fact that in the three cases I have mentioned two distinct species in the northern hemisphere are closely related to one species in the southern hemisphere points also to the same conclusion. The great extent of land in the northern hemisphere will probably explain why the genus *Puffinus*, whose habits are the least oceanic of any, has been so largely developed in those seas, while that of *Procellaria* is restricted to two closely allied species. The only two species of *Procellaria* at present known to inhabit the tropical parts of the Pacific are also each represented in the Southern Ocean—viz., *P. parvirostris* (Peale) by *P. Cookii* (Gray); and *P. rostrata* (Peale) by *P. Lessonii* (Garn.); they both, however, differ more in colour from their types than the Arctic ones do from theirs. *Thalassidroma lineata* (Peale), also from the torrid zone of the Pacific, is a representative species of *T. melanogastra* (Gould).

The shape of the beak of the Petrels is another point well worthy of notice—so formidable is it in appearance, so harmless in reality; the bite of the Albatross even being attended with but little inconvenience, unless the point of the beak happens to catch the hand, as the whole of the inner parts are quite soft, and yield to a slight pressure of the finger. The natural food of the Petrel tribe consists of small fish, the shell-less molluscs, small crustaceans, medusæ, &c., which are swallowed whole, and they do not therefore require a sharp beak fitted for cutting or tearing; for, although they may now and then regale themselves on the body of a dead seal or whale, it is evident that before sealers and whalers existed their opportunities for doing so must have been few and far between—perhaps not more than once in their lives; and if dead whales and seals were their usual food, they would find the tube formed by the nostrils on the top of the beak of many of the species very disadvantageous, as it must prevent them striking their beaks deep into the blubber.

Of what use, then, it may be asked, is the sharp curved point of the beak? I believe it to be of little or no use, but that it simply marks their close relation to, perhaps their direct descent from, the Skuas (*Lestris*), who use it in their attacks upon Gulls. It cannot be said that those species which burrow require a harder beak than the Sand-martin, or that those species which throw up mounds require one stronger or more sharply curved than the Flamingo; and it is certain that for the capture of their prey the hooked point is no more wanted in the Petrels than in the Kingfishers, Herons, Divers, &c., and not so much so as in the Gulls (*Larus*), some of which occasionally kill and devour small birds. This opinion is further strengthened by the fact that the young *P. gigantea* very much resembles in plumage the young *L. catarrhactes*, and it also inherits its habit of chasing other birds.

It is well known that all crepuscular birds have some organ more highly developed than usual, in order to compensate for the difficulty they have in seeing at night; *e. g.*, the ear in the Owl, and the mouth in the Night-jar; and there can be no doubt that the prolongation of the nostrils in the family *Procellaridæ* is for the same purpose. The habits of *Diomedea*, where the tube is reduced to a minimum, are diurnal, except perhaps while the birds are young; they do not therefore require their sense of smell to be more than ordinarily acute. The various species of *Puffinus* and *Pelecanoides*, too, in which the tube is not so well developed as it is in *Procellaria* and *Thalassidroma*, although eminently nocturnal, take their prey chiefly under water, where smell cannot be of much use. The slanting position of their nostrils would also prevent the water being forced into them when diving. The tube is larger in *Procellaria gigantea* than in any other species of the family, and its extremely voracious appetite makes it appear probable that it requires means for obtaining food superior to any of the others.

Another point of great interest connected with these birds is the way they sometimes follow a ship for days together, and are seldom seen to settle on the water. I have been informed by Lieutenant Weld, R. N., that a Cape Pigeon, with a piece of red ribbon round its neck, once followed the ship he was in for 1500 miles, and an albino variety of *P. gigantea* followed Mr. Gould's ship for three weeks, and this bird has by no means the same powers of flight as the Albatross. I myself have sometimes seen the same Albatross, or Cape Pigeon, for several days in succession, while the ship has been going from 150 to 200 miles in the twenty-four hours, but these are exceptional cases. It is, I believe, the generally received opinion of naturalists that these birds, when seen for several days together, have never slept during the whole period, but have followed the ship night and day. To me, however, it appears incredible that any animal should be able to undergo so much exertion for so long a time without taking rest; and I hope to show that it is not necessary to suppose that it does do so. Mr. Gould says that birds caught and marked are generally seen next day, but such is not my experience. I have sometimes marked ten or twelve Cape Pigeons in a day and seldom seen one again. Mr. Gould, however, is quite right when he says that sometimes a marked bird turns up after being absent for two or three days; and how can this be accounted for by the theory of the birds constantly following the ship? Most of the Petrels, more particularly those that burrow, or live in holes in rocks, are, no doubt, nocturnal in their habits when they are on or near land; but when they are at sea, they all become more diurnal. A few can certainly be often seen flying under the stern at night; and once, when I was keeping the middle watch, at about one A. M., a Cape Pigeon, in crossing over the ship, struck a rope, and fell on deck. Still they are never numerous, and where there were fifty or a hundred birds in the daytime there are only one or two at night. Their defenceless condition is, as far as I can see, the only reason for the Petrels hiding themselves by day, and flying by night; for the oceanic mollusca, &c., on which they feed, are equally diurnal and nocturnal. At sea, however, where they have no enemies to fear, and no holes to hide in, the conditions are quite different, and it is then better for them to take their rest at night, and to be alert and feeding in the daytime, and they change their habits accordingly. I therefore believe that, although a few may follow a ship for a night, most of them sleep on the sea; and in the morning, knowing very well that a ship is the most likely place to obtain food, they fly high with the intention of looking for one. Some find the ship that they were with the day before; some another one. In the latter case, if the second ship is going in an opposite direction to the first, they are never seen by the first again; if, however, the course of the two ships is the same, the bird might very likely lose the second ship, and rejoin the first after a lapse of two or three days. A height of 1000 feet would enable a bird to see a ship 200 feet high more than fifty miles off; and often, although unable to see a ship itself, it would see another bird which had evidently discovered one, and would follow it in the same way that vultures are known to follow one another. This opinion is much strengthened by the fact, that at sunrise very few birds are round the ship, but soon afterwards they began to arrive in large numbers, and I think I may safely say that this is always the case; for, having had to be on deck from four to eight o'clock every third morning for six of my voyages, and about once a week during my last voyage, I have had better opportunities for observing this than most people. Sir J. Herschel states, in his "Physical Geography," p. 347, that the Albatross sleeps on the wing; but, to the best of my knowledge, no one has seen this, and it appears to me to be quite impossible; for, as I shall presently show, the bird cannot sustain itself in the air unless it has an onward movement; and if this movement was given by the wings, sleep would be no rest to it.

The unrivalled flight of the Albatross has been the admiration of voyagers from the earliest time. Day after day, with unabated interest, I have watched them, and I quite agree with Mr. Gould that the Sooty Albatross (*D. fuliginosa*) carries off the palm from all competitors. Never have I seen anything to equal the ease and grace of this bird as he sweeps past, often within a few yards, every part of his body perfectly motionless except the head and eye, which turn slowly, and seem to take notice of everything. I have sometimes watched narrowly one of these birds sailing and wheeling about in all directions for more than an hour without seeing the slightest movement of the wings. This, however, is longer than usual.

Wonderful as is this power of flight, it can all be explained by the simple mechanical laws which govern the direction and magnitude of pressures. Dr. Bennett states that he believes "that the whole surface [of the body of the Albatross] is covered by numerous air cells, capable of a voluntary inflation or diminution by means of a beautiful muscular apparatus. . . . . . . By this power the birds can raise or depress themselves at will." Now, I do not for a moment doubt the existence of this apparatus, for it is well known that all birds have it to a greater or less extent; but I *do* doubt its capability of doing the duty assigned to it—viz., raising the bird in the air. The temperature of the Albatross, as taken by Sir G. Gray, by placing a thermometer under the tongue, is 98° F.; and if we add 10° F. to this, in order to allow for the difference between the head and the body, we shall have the temperature of the air cells at 108° F. The temperature of the surrounding air cannot be taken lower than 48° F., as the mean winter temperature of lat. 50° south is about 50° F. The bird, therefore, could not raise the temperature of the air taken into these cells more than 60° F. This would increase its volume not quite one-eighth; and taking 100 cubic inches of air to weigh thirty-one grains, and the average weight of an Albatross to be 17lbs., as given by Gould, it would be necessary, in order that the specific gravity of the bird might be brought to that of the atmosphere, that these cells should contain 1820 cubic feet of air; or, in other words, they must be more than 1200 times the size of the body itself of the bird, which, to say the least, would give it when flying an aldermanic appearance, which I have never observed. In fact, it would require a sphere of more than fifteen feet in diameter to contain the necessary quantity of air. Even if it could thus buoy itself up, it would entirely defeat its own object; for it would at once destroy the whole of its momentum, and, unless propelled forward by its wings, would drift helplessly to leeward. However, I do not wish it to be inferred that I consider the air cells of no use. The greater portion of them are situated round the neck, wings, and forepart of the body of the bird; and I believe that by their means he is enabled to shift slightly the position of his centre of gravity, and thus, with very slight muscular exertion, to vary the inclination of his body to the horizon, according to the rate at which he is moving through the air.

Dr. Bennett also* gives a diagram explanatory of the flight of the Albatross; and, if I understand him rightly, says that it cannot sail† directly against the wind, but only in the way which sailors call "close-hauled." This diagram represents a square-rigged ship sailing six points from the wind, a cutter sailing four and a half points, and an Albatross flying two points from the wind; from which I infer, although he does not expressly say so, that he considers that the wind helps forward the Albatross in the same way that it does the ships. But that this is erroneous is apparent at a glance. A ship can sail at an acute angle with the wind, because the pressure of the wind against its sails, being met by the resistance of the water, is resolved into pressures having other directions. Advantage of this being taken by trimming the sails, it ultimately results that the ship is moved in the direction of least resistance—viz., forwards. If, however, the pressure of the wind has not been met by the resistance of the water, no resolution of it into other directions could have taken place. For this reason a balloon can only drift with the wind, and the same would be the case with the Albatross. Moreover, the statement that he cannot sail against the wind is incorrect,‡ as Dr. Bennett himself said in his first book; the truth being that he is more often seen sailing in this direction than in any other, for the simple reason that, as he moves slower against the wind than with it, he is obliged to keep going for a longer time in the former direction than in the latter, in order to retain his position near the stern of the ship. However; when sailing against the wind, the position of his wings, body, and tail, slanting a little downwards, is somewhat analogous to the sails of a ship close-hauled, or, still better, to the position of a kite in the air; the momentum of the bird taking the place of the resistance of the water, or the string of the kite. This momentum is entirely owing to impulses previously given to the air by means of his wings; and when, owing to the resistance of the air, it has decreased so much that he is no longer able to move with sufficient rapidity to prevent his falling, fresh impulses have to be given. For this reason Albatrosses sail much longer in fine than in stormy weather; rain, especially, soon destroying their momentum, and frequently obliging them to use their wings for propulsion. It is by combining, according to the laws of mechanics, this pressure of the air against his wings with the force of gravity, and by using his head and tail as bow and stern rudders, that the Albatross is enabled to sail in any direction he pleases, so long as his momentum lasts. If, when sailing against the wind, the inclination of his body is such that the upward pressure of the wind against his wings and body just balances the force of gravity, his momentum alone acts, and he sails straight in the "wind's eye." If he wishes to ascend, he inclines his body more to the horizon by means of his head and tail. If he wishes to turn to the right, he bends his head and tail slightly upwards, at the same time raising his left side and wing, and lowering the right in proportion to the sharpness of the curve he wishes to make, the wings being kept quite rigid the whole time. To such an extent does he do this, that in sweeping round, his wings are often pointed in a direction nearly perpendicular to the sea; and this position of the wings, more or less inclined to the horizon, is seen always and only when the bird is turning. It will be observed that on this principle an Albatross sailing down wind must necessarily be descending, unless his pace is much greater than that of the air, and such I have found to be invariably the case. It may be objected that the resistance of the air must soon destroy his momentum; but the fact is, that it does not do so. A good illustration of this is seen in an experiment, common in lecture rooms a few years ago, by which the rotation of the earth was demonstrated by means of a pendulum, composed of a metal ball suspended by a string from the ceiling of the lecture hall. The impetus obtained by causing the metal ball to fall through the space of a few feet only was sufficient to keep the pendulum swinging with a velocity but little diminished for the greater part of an hour, notwithstanding the resistance of the sand, which the point of the pendulum had to cut through twice during each vibration. The resistance of the air is well known to depend on the shape and velocity of the moving body, and to increase in proportion much more rapidly than the velocity increases. For this reason, a properly shaped body and a low velocity are required to reduce it to a minimum. A certain amount of weight is also necessary to give a bird momentum sufficient to overcome the resistance for a certain time, and wings are required of sufficient expanse to support it as it sails slowly through the air. These conditions are admirably carried out in the Albatross; its expanse of wing is perhaps greater than that of any other bird, and its weight, 15lbs. and upwards, is very large. Its shape, also, when the neck is stretched out, as in flying, approaches very nearly to that of Newton's solid of least resistance, while more than one voyager has remarked the slowness with which it sails past. The Petrels now under consideration sail very nearly in proportion to their size and weight. The Stormy Petrel never sails; the Cape Pigeon, only for a very short time, perhaps a minute; the Night Hawk, much longer, often between five and six minutes; while the Albatross, as I have before mentioned, sometimes for an hour, "rising and falling," says Dr. Bennett, "as if some concealed power guided its various motions without any muscular exertion of its own;" but which we must only look upon as another illustration of the small resistance offered by the air to the passage of a properly shaped heavy body moving through it with a low velocity.

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* "Gatherings of a Naturalist."

† In this paper I use word "sail," for want of a better one, to denote the power these birds possess of flying for a considerable time without moving their wings, and the following remarks relate to this mode of flying only.

‡ "Wanderings in New South Wales."

Captain Hutton's paper was illustrated by drawings of all the birds mentioned, mostly life size, executed by himself; also by smaller sketches, illustrative of the flight of the Albatross.

The President said, Captain Hutton's very interesting paper was a sufficient introduction of that gentleman to the meeting. He had stated what he saw himself, and therefore his communication had a peculiar value. He had had opportunities of observing the birds of the Southern ocean that were enjoyed by few. On the highly interesting question of the sea birds of the Southern Ocean following ships—a fact that had attracted the attention of every navigator in the South Sea from the time that Coleridge's "Ancient Mariner" had lived, and before it—Captain Hutton had thrown a great and a very curious light. He (the President) perfectly agreed with the results at which he had arrived from numerical calculation, as to the floating power of air cells, being of opinion, with him, that it was perfectly ludicrous to attribute to the influence of the heated air in those cells in the bones of the birds any sustaining power for the purposes of flight or motion in the air, even in the coldest latitudes. Captain Hutton's calculations, in his opinion, demolished that supposition completely. It was easy to destroy wrong opinions, but difficult to rebuild right ones on their ruins; nevertheless he thought that Captain Hutton had constructed the true theory of the sailing powers of those birds in the closing observations of his paper, which possessed, in his mind, a great and important value. The square-rigged ship, as he had stated, sails within 67° of the wind, and the cutter within from 45 to 50° of it, whereas the Albatross goes within 22½° of the wind. Now, that phenomenon would be perfectly inexplicable if they supposed the Albatross to "sail" upon the same principles that determined the motion of the cutter or square-rigged ship, when "close-hauled;" and therefore he quite concurred with Captain Hutton's idea, that the original momentum of the bird must be taken into account in estimating the closeness with which it "sails" to the wind. The Albatross could not be so much better rigged than the ship or cutter, as to be able to go so much closer than they can, of its own accord, and with only the assistance of heated air in its cells; it was, therefore, evident that that power in the bird was due very much to the momentum acquired by muscular force in its previous rapid flight. From Captain Hutton's descriptions, as well as from what he had read concerning the flight of this bird, he had no doubt that the true parallel for its motive power, as well as that of the Gannet, was the steamer, and not the sailing vessel. The muscular motive powers of both birds were situated, in nautical phrase, far "aft." He was sorry Captain Hutton had not brought home some of the muscles of the Albatross; the skin and bones afforded much less information than the soft parts. With respect to the points touched on in the earlier part of the paper, as to the varieties of some of the birds described, and as to the question of maturity or immaturity having been mistaken for distinctness of species, he did not feel so competent to express an opinion as some other gentlemen who were present.

Mr. Andrews said, he had listened with much pleasure to the paper just read by Captain Hutton, as his were views drawn from actual observation of the habits and distribution of the Pelagic birds of the Southern latitudes. He (Mr. Andrews), however, believed that very considerable confusion existed in the naming of several species—in fact, confounding the young or immature bird with other species, or making them altogether distinct as species from the mature bird. Cases of identity are seen in many of our aquatic birds, especially in one (*Puffinus obscurus*), the Dusky Petrel, which was noticed and exhibited in this Society some years since as being captured off the Island of Valentia, coast of Kerry, on the night of the 11th of May, 1853, when it flew on board a sloop as the vessel entered the harbour. This bird, which frequents the shores of Africa and the Cape of Good Hope, and has also been noticed off Madeira, is the only one recorded as occurring on our shores, or on those of Britain. It is identical with *Puffinus assimilis* (Gould), described as occurring off Norfolk Island, New Zealand, and the shores of Eastern Australia. It is also closely similar to the Manx Shearwater, *Puffinus Anglorum*, but of smaller size. The Great Shearwater, *Puffinus major*, or *Puffinus cinereus*, is identical with *Puffinus fuliginosus* (Strickland), and is closely allied to, and identical in habit with, *Procellaria hæsitata*, the great Grey Petrel of the seas of Australia. *Puffinus cinereus* is seldom seen near our shores, although at one time, after a gale of wind, and during a fog succeeding, they were in myriads in Dingle Bay, and many were taken on the fishermen's lines. It is truly a pelagic bird, and seen at long distances from the land when crossing the Atlantic. There are several rare sea birds that breed on the islands of our southwest coast. *Lestris catarrhactes* has been met on the Tearaght; the Manx Shearwater, on the Skelligs and Valentia; and the egg of Bulwer's Petrel, *Thallassidroma Bulweri*, has been taken on the Little Skellig Island, where the Gannet breeds in numbers. Many rare Petrels and Shearwaters breed on and frequent islands called the Dezertas—a small group about six leagues from Madeira—and it is not improbable that *Puffinus obscurus* may be found there.

Our late lamented Secretary, Professor Kinahan, from notes he had made on the birds of the Southern Seas, had noticed the several species of Diomedea, and their habits; he had seen them as far south as Cape Horn. He had remarked the variation of the immature birds, which some authors had considered to be species, and he agreed with what I had stated of the extensive ranges taken by the young or immature birds in northern latitudes, some visiting our own shores, where the mature birds were rarely ever seen.

Professor Jukes said, he would not enter at all into the question mentioned by Mr. Andrews, upon which he felt incompetent to speak; he would only express the extreme pleasure it had afforded him to listen to Captain Hutton's paper. It brought back in a most vivid manner old associations of twenty years ago—facts that occurred, and things that had interested him when sailing in those seas formerly himself. He could not but compliment Captain Hutton on the very graphic way in which he had described and figured all those birds. He (Prof. Jukes) had not seen all of them. He could not call to mind any except the Albatross and the Cape Pigeons, which were seen by every voyager round the Cape of Good Hope, and from that to Van Diemen's Land. The *Shearwaters* he had seen further north. The whole of the sea from some two or three degrees south of the Cape of Good Hope to Van Diemen's Land was alive with birds to a degree that was not to be observed in any other part of the ocean. In the Atlantic only an odd bird or two were met with, as a rule—perhaps a Frigate Bird soaring in the zenith—until land was approached on shoals, like the Bank of Newfoundland, which, being covered with fish, also swarmed with birds of different descriptions. But in the Indian Ocean, in latitude about 35°, or thereabouts, the air was alive with birds, and the water was alive with Cape Pigeons, while great Albatrosses could be seen sailing over the ships. Once, while on a voyage in those seas, he and others divided the horizon into quarters, for the purpose of making a hasty estimate of the number of Albatrosses in sight at the same time, and they counted no less than 400. Catching the Albatross with a line and hook, baited with a bit of pork, was only practicable when the ship was sailing slowly—say, about three knots an hour. Captain Hutton's description of this was quite accurate; the Albatross comes awkwardly down into the water, with a loud croak, and the Cape Pigeons instantly get out of his way; he then picks up the piece of pork and is hauled on board. He had often cut Albatrosses open and invariably found nothing in their stomachs except the beaks of Cuttle Fish. He had met these birds, in the way he had described, thousands of miles from land.

Mr. Robert J. Montgomery asked Captain Hutton where the *Lestris catarrhactes* bred? In the Orkney Islands the *L. catarrhactes* was to be found breeding in lofty cliffs, and not on the ground, like some of the Gulls.

Dr. E. H. Bennett said, that Captain Hutton's paper noticed an anatomical point of considerable interest—namely, the structure of the bill of the Albatross. He understood him to say that the bill of that bird was not, so far as its structure was concerned, the best suited for taking its prey, but was, in fact, rather peculiar to the species, than adapted to the mode of life of the individual to which it belonged. This was at variance with what was observed in the Kingfisher, and in other aquatic birds. The fact was important, when it was remembered that in every department of anatomy facts turned up in this way; and it depended upon what interpretation they put on them—whether they proved community of descent, or unity of type, or special adaptation to particular modes of life. He did not know that this fact had been previously noticed in connexion with the same class of birds. With reference to the explanation he had given of the mode of flight of the Albatross, he presumed that Captain Hutton did not claim originality, as it corresponded with the account given by Darwin of the flight of the Condor.

Captain Hutton said, he was very much pleased that so high an authority as Dr. Haughton should have sanctioned his numerical calculations. They were not very deep, but still Dr. Haughton's concurrence was a satisfactory guarantee against mistakes. The question as to whether the birds of the Northern and the Southern Hemispheres were distinct species or not was an open one to naturalists, since what a "species" was had not been defined—whichever view might be taken of it did not affect his statement that the birds crossed over from the southern to the northern seas. Moreover, there were differences sufficient to enable a person looking at them to say whether they had come from the Arctic or the Antarctic Seas. Mr. Andrews had said that the *Puffinus cinereus* was related to the *Procellaria hæsitata* (Licht.), and he was quite right; the differences between them, however were sufficient to place them in different genera. The *genus* of these birds was mainly determined by the form of their nostril. The *Procellaria hæsitata* had the long tubular nostril of a *Procellaria*, while the *Puffinus cinereus* had it much less developed, and the opening slanting upwards—in fact, a real *Puffinus* beak.

Mr. Andrews said, the difference is very slight.

Captain Hutton admitted it to be slight, but still it constituted a distinction between the two. You can always tell the *Procellaria hæsitata* from the *Puffinus cinereus* by the look of the nostril. The *Puffinus fuligi-*

nosa is a Northern, and not a Southern Petrel, and is the young of the *Puffinus major*. Captain Hutton also remarked that this Petrel (*P. hæsitata*) is a sea-going one. It is a *Procellaria*, having the habits of that genus, and is found thousands of miles from land, like the Albatross. In the Southern Ocean the Shearwaters are never found far from land. The *Puffinus obscurus* is a northern species, found in Newfoundland; it is also one of the birds that fly up and down the Bosphorus, and are never seen to settle, the other being the *Puffinus Anglorum*. In reply to Mr. Montgomery, the *Lestris catarrhactes* breeds always on low flat grounds, amongst grass two or three feet high; it makes no nest, and lays two or three eggs. With respect to an observation of Dr. Bennett, Captain Hutton said, he did not remember having read Darwin's description of the flight of the Condor until after he had written his paper.

XVI.—On the Evaporation of a Water Surface at St. Helena.

By the Rev. Samuel Haughton, M. D., Fellow of Trinity College, Dublin.

[Read before the Royal Irish Academy, June 27, 1864.]

I have already published in the "Proceedings" of the Academy the results of one year's Observation on the Difference of Rain-fall and Evaporation made at St. Helena by Lieutenant Haughton, R. A., in 1860–61. Through the kindness of this officer, and of Major Phillipps, commanding Royal Artillery at St. Helena, I am enabled to lay before the Academy on the present occasion two years' Observation on Evaporation and Rainfall, made at the same place, and under better conditions.

The former observations were made in a glass cylinder, 9 inches high, and 4·85 inches wide, and gave only the excess of Evaporation above Rain-fall. The present Observations were made in two cylinders, one circumstanced like the last, and the other placed in a large tub of water, so as to have the water inside the cylinder always surrounded by water at nearly the same level, thus giving a better approximation to the true evaporation from a water surface surrounded by water.

At the same time, Major Phillipps recorded carefully the Rain-fall; and from a comparison of both sets of Observations, I have obtained the actual amount of Evaporation, corrected for Rain-fall, during the two years.

Part I.—Lieutenant Haughton's Observations on the Difference of Evaporation and Rain-fall.

Observations on Evaporation resumed at $10^h\ 45^m$ A. M., on Sunday, 3rd August, 1862, with the old glass as before; and another, about the same size, immersed in water up to the zero point.

A is the depth of the water evaporated in one week in the new glass immersed in water.

B, ditto, in the former glass.

		Inches. *A*.	Inches. *B*.
AUGUST	10, 1862, . .	1·00	1·30
„	17, ...	1·50	2·10
„	24, ...	1·00	1·40
„	31, ...	1·20	1·70
SEPT.	7, ...	1·50	2·00
„	14, ...	1·80	2·40
„	21, ...	1·50	2·00
„	28,[1]	1·10	1·60
OCTOBER	5, ...	1·60	2·10
„	12, ...	—	2·10
„	19, ...	1·40	1·80
„	26, ...	1·60	2·30
NOVEMB.	2, ...	1·60	2·30
„	9, ...	1·35	2·00
„	16.	—	—
„	23,[2].	2·10	3·55
„	30, ...	1·15	1·90
DECEMB.	7,[3]	1.55	2·10
„	14,[4]	1·65	2·20
„	21, ...	1·45	1·15
„	28, ...	1·50	2·25
JANUARY	4, 1863, . .	1·55	2·50
„	11, ...	1·65	2·70
„	18, ...	1·10	1·75
„	25, ...	1·30	1·95
FEBRUARY	1, ...	1·55	2·50
„	8, ...	1·40	2·30
„	15, ...	0·90	1·90
„	22, ...	1·40	2·45
MARCH	1, ...	1·40	2·25
„	8, ...	1·00	1·90
„	15,	—	—
„	22,[5]	2·00	3·90
„	29, ...	1·80	3·00
APRIL	5, ...	1·75	2·70
„	12, ...	0·90	1·70
„	19, ...	1·25	2·35
„	26, ...	1·35	2·35
MAY	3, ...	1·85	2·80
„	10, ...	1·75	3·00
„	17, ...	1·70	2·90
„	24, ...	1·65	2·55
„	31, ...	1·25	2·00
JUNE	7, ...	1·30	2·20
„	14, ...	1·05	1·75
„	21,[6]	—	—
„	28,[7]	0·20	– 0·40
JULY	12,[8] . . .	– 0·70	– 1·50
„	19, . . .	– 1·00	– 1·50
„	26, ...	– 0·40	– 0·70
AUGUST	2, ...	1·20	1·50
„	9, ...	1·35	1·80
„	16, ...	1·30	1·65
„	23, ...	1·10	1·50
„	30, ...	1·00	1·65

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[1] The level of the water is always below zero at the end of the week.

[2] For two weeks.

[3] Level of water in tub half an inch above that in the glass.

[4] Water in tub again a little above that in glass.

[5] For two weeks.

[6] Not recorded, but very small.

[7] The first instance of an excess of rain.

[8] For two weeks, during which time a net covered both glasses. I had placed it there fearing the birds had been in the habit of drinking the water; but I removed the net to-day, because, on consideration, I thought it would have a tendency to conduct the drops of rain away from the glass. I have never seen any birds on the roof, and I think they could not reach the water in the glasses, no matter how thirsty they might be.

	Inches. *A.*	Inches. *B.*
SEPT. 6,	0·70	1·10
„ 13,	0·20	1·40
„ 20,	1·20	1·50
„ 27,	0·80	1·20
OCTOBER 4,	1·10	1·40
„ 11,	1·30	1·70
„ 18,	1·70	2·10
„ 25,	1·10	1·60
NOVEMB. 1,	1·40	1·70
„ 8,	1·70	2·00
„ 15,	1·75	2·30
„ 22,	1·55	2·00
„ 29,	—	—
DECEMB. 6,	1·60	2·00
„ 13,	1·50	2·00
„ 20,	1·75	2·35
„ 27,	—	—
JANUARY 3, 1864,	—	—
„ 10,[1]	3·86	5·63
„ 17,	1·37	2·16
„ 24,	1·65	2·35
„ 31,	1·50	2·30
FEB. 7,	1·25	2·00
„ 14,	1·75	2·35
„ 21,	1·15	1·70
„ 28,	1·60	2·40
MARCH 6,	1·25	2·00
„ 13,	1·65	2·50
„ 20,	1·35	2·15
„ 27,	1·80	2·60
APRIL 3,	1·70	2·50
„ 10,	1·20	2·00
„ 17,	0·90	1·50
„ 24,	1·50	2·25
MAY 1,	1·60	2 45
„ 8,[2]	1 45	2·20
„ 15,[3][4]	0·25	0·85
„ 22,	0·75	1·45
„ 29,	1·30	1·95
JUNE 5,	—	—
„ 12,[5]	2·10	3·25
„ 19,	0·55	1·20
„ 26,	0·90	1·45
JULY 3,	0·80	1·35
„ 10,	1·10	1·70
„ 17,	1·25	1·85
„ 24,	1·05	1·70
„ 31,	—	—
AUGUST 7,[6]	1·10	2·20
„ 14,	0·85	1·35
„ 21,	1·25	1·75
„ 28,	1·05	1·60
SEPT. 4,	1·10	1·65
„ 11,	1·40	2·15
„ 18,	0·80	1·30
„ 25,	1·40	2·05
OCTOBER 2,	1·30	1·90
„ 9,	1·45	2·05
„ 16,	1·45	2·10
„ 23,	1·60	2·25
„ 30,	—	—
NOV. 6,[7]	2·70	3·75
„ 13,	—	—
„ 20,[8]	2·50	3·60
„ 27,	1·70	2·36
DEC. 4,	1·00	1·90
„ 11,	1·02	1·63
„ 18,	1·60	2·50
„ 25,	1 50	2·25

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[1] For three weeks.

[2] Taken 3 hours late.

[3] Great mountain torrent at Sandy Bay on the 11th.

[4] Cleaned out the glasses.

[5] For two weeks.

[6] For two weeks.

For two weeks.

[8] For two weeks.

PART II.—MAJOR PHILLIPPS'S OBSERVATIONS ON THE RAIN-FALL AT ST. HELENA.

Height above the Sea, 700 *Feet.*

LADDER HILL, ST. HELENA.

Year.	Date.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
1861.	1st, . . .	No Observations taken.	Ditto.	No Observations taken.	0·02	..	No Observations taken.	..	0·11	..	0·01	0·02	..
	2nd, . . .				..	..		..	0·08	..	..	0 01	0·01
	3rd, . . .				..	0·33		0·11	0 05	..	0·01	0 01	..
	4th, . . .				..	0·04		..	0·04	..	..	0·01	..
	5th, . . .				..	..		0·02	0·02	..	..	0·02	..
	6th, . . .				0·45	..		0·06	0·30	0·01	..	0·01	..
	7th, . . .				0·19	..		0·47	0·00	..	..	0·03	0·01
	8th, . . .				0·16	..		0·11	..	..	..	0·04	0·02
	9th, . . .				0·08	0·02		0·16	0·01	0·01	0·01	..	0·19
	10th, . . .				0·07	0·04		0·13	0·27	..	0·04	..	0·03
	11th, . . .				..	0·04		0·02	0·01	0·05	0·01	..	0·01
	12th, . . .				0·02	0·61		0·02	0·06	..	..	..	0·03
	13th, . . .				0·13	0·12		..	0·05	0·06	..	..	0·03
	14th, . . .				0·07	No Observations taken.		..	0·54	0·01	..	..	..
	15th, . . .				..			..	0·28	..	..	0·05	0·08
	16th, . . .				..			..	0·05	..	..	..	0·01
	17th, . . .			0·30	..			..	0·01	0·02	..	..	0·01
	18th, . . .			0·14	..			..	0·03	0·06	0·01	0·02	..
	19th, . . .			0·01	0·03			..	..	0·01	..	0·01	..
	20th, . . .			..	0·05			0·10	..	0·05	0·01	0·03	..
	21st, . . .			0·07	0·05			0·01	..	0·10	0·02	0·02	..
	22nd, . . .			0·05	..			0·07	..	0·08	0·02	0·01	..
	23rd, . . .			0·05	..			0·02	..	0 08	0·01	0·01	..
	24th, . . .			0·20	0·08			0·11	0·17	0·03	0·05	0·02	..
	25th, . . .			0·18	..			0·35	0·02	0·01	..	..	..
	26th, . . .			0·02	..			0·04	0·01	..	..	..	0·01
	27th, . . .			..	0·03			0·20	..	..	..	..	..
	28th, . . .			0·06	..			0·15	..	..	..	0·02	0·08
	29th, . . .			..	..			0·04	..	0·06	..	0·01	0 03
	30th, . . .			..	..			0·06	..	0·01	0·01	..	0·02
	31st, . . .			..	..			0·08	..	..	0·04		0·03

The Rain Gauge used was a zinc funnel, five inches diameter, made by Messrs. Negretti and Zambra, placed in a bottle buried to the neck in earth. Rain-fall was measured in a glass having one inch of rain divided into 100 parts. Observations were taken at 9 A. M. each day.

TABLE *showing the Rain-Fall at Ladder Hill, St. Helena. Height above the Sea,* 700 *Feet.*

LADDER HILL, ST. HELENA.

Year.	Date.	January.	February.	March.	April.	ay.	June.	July.	August.	September.	October.	November.	December.
1862.	1st, . .	..	·01	..	..	·03	·01	·03	·18	·01	..	..	..
	2nd, . .	..	·04	·02	..	·01	..	..	·25	..	·02	..	..
	3rd, . .	..	·20	11	..	..	..	·09	·09	..	·02	·02	..
	4th, . .	..	·03	·05	..	..	..	·16	·02	..	..	..	·01
	5th, . .	·05	·14	·01	..	..	·02	·09	..	..	..	..	·02
	6th, . .	·14	·03	..	..	..	..	·14	..	·01	·03	..	·07
	7th, . .	·02	·01	·30	..	..	..	·13	·24	..	·05	..	·07
	8th, . .	·03	..	·20	·06	..	..	·03	·07	..	·12	..	·02
	9th, . .	·05	..	·02	·01	..	..	..	·10	..	·01	..	·01
	10th, . .	·04	..	·01	..	..	..	·28	·05	..	·01	..	..
	11th, . .	·04	·01	..	·03	..	·05	·37	·02	..	·10	..	..
	12th, . .	..	..	·01	·13	..	·07	·04	..	..	·02	·05	..
	13th, . .	..	·05	·05	·09	..	..	·03	..	..	..	·01	.
	14th, . .	..	·22	·02	·01	..	·28	..	..	·06	·02	..	..
	15th, . .	·04	·07	·01	·03	..	·09	·47	..	·03	·17	·13	..
	16th, . .	·03	·01	·02	·04	..	·38	·27	·04	·01	·06	·07	..
	17th, . .	..	·01	·13	03	..	·71	·10	·09	..	·05	·06	..
	18th, . .	·02	..	·17	·32	·10	·27	·02	·05	·05	·07	·06	..
	19th, . .	·01	..	·20	·31	·21	·11	·07	·01	·06	·14	·05	..
	20th, . .	·06	..	·02	·36	·16	·10	·23	..	·04	·01	·02	..
	21st, . .	·05	·01	..	·01	..	·13	·12	..	·07	..	·03	..
	22nd, . .	..	..	..	..	·02	·10	·07	·01	·04	..	·01	..
	23rd, . .	·05	·02	..	..	·11	·01	·18	..	·03	..	..	·07
	24th, . .	·05	·04	..	·03	·05	·21	·03	..	·01	..	·02	·08
	25th, . .	·16	·06	..	·03	..	·12	..	..	·01	..	·02	·05
	26th, . .	·01	·08	..	·04	·01	·10	..	..	·10	..	·02	·02
	27th, . .	·17	·04	..	..	..	·55	..	·03	·01	..	·11	·01
	28th, . .	·69	..	..	..	·05	·03	·05	·01	..	..	·15	·01
	29th, . .	·72	..	..	..	·10	·08	·04	·03	·06	..	·02	·08
	30th, . .	·16	..	..	·08	·08	·06	·05	·08	·01	..	..	·01
	31st, . .	·03	..	·03	..	·06	..	·21	·06	..	..	..	·12

The Rain Gauge used was a zinc funnel, of five inches diameter, made by Messrs. Negretti and Zambra, placed in a bottle buried to the neck in earth. Rain-fall was measured in a glass having one inch of rain divided into 100 parts. Observations were taken at 9 A. M. each day.

SUMMARY.

Month.	Days on which Rain fell.	Total Rain-fall in Inches.
January, ...	22	2·62
February, ...	19	1·08
March, ...	18	1·38
April, ...	17	1·61
May, ...	13	0·99
June, ...	21	3·48
July, ...	25	3·25
August, ...	19	1·43
September, ...	17	0·61
October, ...	16	0·90
November, ...	17	0·85
December, ...	15	0·65
Total during 1862, . .	**219**	**18·85**

LADDER HILL, ST. HELENA.

Month.	Date.	Rain.	Remarks.	Month.	Date.	Rain.	Remarks.
JANUARY, 1863.	1	0·02	Recorded by Major Phillipps, R. A.	FEBRUARY, 1863.	1	0·11	Recorded by Major Phillipps, R. A.
	2	..			2	0·04	
	3	..			3	..	
	4	0·05			4	..	
	5	..			5	0·10	
	6	0·02			6	0·03	
	7	..			7	0·04	
	8	0·01			8	0·06	
	9	..			9	0·08	
	10	..			10	0·46	
	11	0·04			11	0·05	
	12	0·03			12	0·08	
	13	0·02			13	0·29	
	14	..			14	0·12	
	15	0·07			15	0·16	
	16	0·09			16	0·09	
	17	0·03			17	0·15	
	18	0·04			18	0·15	
	19	0·01			19	..	
	20	..			20	..	
	21	0·06			21	0·01	
	22	0·01			22	..	
	23	0·03			23	..	
	24	0·04			24	0 12	
	25	0·01			25	0·15	
	26	..			26	0·24	
	27	..			27	0·02	
	28	..			28	0·01	
	29	0.05					
	30	0·04					
	31	..					
Total Rain-fall, . . **0·67** of a inch.				Total Rain-fall, . . . **2·56** inches.			

LADDER-HILL, ST. HELENA.

Month.	Date.	Rain.	Remarks.	Month.	Date.	Rain.	Remarks.
MARCH, 1863.	1	0·15	Recorded by Lieut. F. T. Lloyd, R. A.	APRIL, 1863.	1	. .	Recorded by Ensign G. H. Evans, St. Helena Regiment.
	2	0·17			2	0·01	
	3	0·06			3	. .	
	4	0·01			4	. .	
	5	0·04			5	0·03	
	6	0·05			6	0·25	
	7	0·34			7	0·21	
	8	0·05			8	0·19	
	9	0·09			9	0·01	
	10	0·51			10	0·02	
	11	0·40			11	0·15	
	12	0·49			12	. .	
	13	0·29			13	. .	
	14	0·10			14	. .	
	15	0·02			15	. .	
	16	0·01			16	0·11	
	17	. .			17	0·59	
	18	0·10			18	0·02	
	19	0·01			19	. .	
	20	0·13			20	0·03	
	21	0·03			21	0·05	
	22	. .			22	0·03	
	23	. .			23	0·02	
	24	0·04			24	. .	
	25	. .			25	0·04	
	26	0·01			26	. .	
	27	. .			27	0·03	
	28	0·09			28	. .	
	29	0·04			29	. .	
	30	. .			30	. .	
	31	0· 0					
Total Rain-fall, . . . **3·24** inches.				Total Rain-fall, . . . **1·79** inches.			

LADDER HILL, ST. HELENA.

Month.	Date.	Rain.	Remarks.	Month.	Date.	Rain.	Remarks.
MAY, 1863.	1	. .	Recorded by Ensign G. H. Evans, St. H. Regt.	JUNE, 1863.	1	0·07	Recorded by Lieutenant John Haughton, R. A.
	2	. .			2	0·01	
	3	. .			3	0·01	
	4	. .			4	. .	
	5	. .			5	. .	
	6	. .			6	. .	
	7	. .			7	. .	
	8	. .			8	0·05	
	9	. .			9	0·05	
	10	. .			10	0·04	
	11	0·01			11	. .	
	12	. .			12	. .	
	13	. .			13	. .	
	14	. .			14	. .	
	15	. .			15	. .	
	16	. .			16	0·66	
	17	. .			17	0·12	
	18	. .			18	0·14	
	19	. .			19	0·25	
	20	. .			20	0·30	
	21	. .			21	0·69	
	22	. .			22	. .	
	23	. .			23	0·02	
	24	. .			24	0·04	
	25	. .			25	. .	
	26	0·04			26	0·01	
	27	. .			27	1·02	
	28	0·01			28	0·20	
	29	. .			29	. .	
	30	0·25			30	0·15	
	31	0·08					
Total Rain-fall, . . 0·39 of an inch.				Total Rain-fall, . . . 3·83 inches.			

LADDER HILL, ST. HELENA.

Month.	Date.	Rain.	Remarks.	Observations.
JULY, 1863.	1	0·32	Recorded by Major Phillipps, R. A.	**Rain Gauge.**—Negretti and Zambra's zinc funnel, five inches in diameter, placed in a bottle buried in the earth. The rain was measured in a glass, having one inch of rain divided into 100 parts. **Thermometer.**—Maximum taken from a mercurial thermometer; minimum taken from a spirit thermometer: both placed in the shade, and as much as possible out of the wind. The thermometers are self-registering. Paul W. Phillipps, Major, R. A. *Ladder Hill, St. Helena, August* 12, 1863.
	2	. .		
	3	0·16		
	4	0·09		
	5	0·16		
	6	0·22		
	7	0·10		
	8	0·32		
	9	0·41		
	10	0·16		
	11	0·04	Recorded by Lieutenant John Haughton, R. A.	
	12	. .		
	13	0·03		
	14	0·01		
	15	0·05		
	16	No observation.		
	17	0·10		
	18	0·12		
	19	0·17		
	20	0·02		
	21	0·15		
	22	. .		
	23	0·19		
	24	0·09		
	25	0·32		
	26	0·09		
	27	0·08		
	28	0·12		
	29	No observation.		
	30	. .		
	31	. .		
Total Rain-fall, . . .		3·52 inches.		

LADDER HILL, ST. HELENA.

Month.	Date.	Rain.	Remarks.	Month.	Date.	Rain.	Remarks.
AUGUST, 1863.	1	..	Recorded by Major Phillipps, R. A.	SEPTEMBER, 1863.	1	0·12	Recorded by Major Phillipps, R. A.
	2	..			2	0·16	
	3	..			3	0·02	
	4	..			4	..	
	5	..			5	0·13	
	6	0·01			6	0·04	
	7	..			7	..	
	8	..			8	..	
	9	..			9	0·08	
	10	0·01			10	0·02	
	11	0·03			11	0·04	
	12	0·04			12	..	
	13	0·03			13	..	
	14	0·04			14	..	
	15	0·01			15	..	
	16	..			16	..	
	17	0·21			17	..	
	18	0·03			18	..	
	19	0·03			19	0·07	
	20	0·19			20	0·03	
	21	0·03			21	..	
	22	0·04			22	0·04	
	23	..			23	0·13	
	24	..			24	0·20	
	25	0·01			25	0·02	
	26	..			26	0·03	
	27	..			27	0·01	
	28	..			28	0·02	
	29	0·03			29	0·11	
	30	0·07			30	0·07	
	31	0·03					
Total Rain-fall, 0·84 of an inch.				Total Rain-fall, . . . 1·35 inches.			

LADDER-HILL, ST. HELENA.

Month.	Date.	Rain.	Remarks.	Month.	Date.	Rain.	Remarks.
OCTOBER, 1863.	1	0·14	Recorded by Major PHILLIPPS, R. A.	NOVEMBER, 1863.	1	0·01	Recorded by Major PHILLIPPS, R. A.
	2	0·10			2	..	
	3	0·07			3	0·01	
	4	0·06			4	..	
	5	0·01			5	..	
	6	0·11			6	..	
	7	0·07			7	..	
	8	0·01			8	..	
	9	..			9	..	
	10	0·05			10	..	
	11	0·01			11	0·02	
	12	..			12	..	
	13	..			13	..	
	14	0·03			14	..	
	15	..			15	..	
	16	0·02			16	..	
	17	0·03			17	0·02	
	18	0·10			18	..	
	19	0·07			19	0·01	
	20	0·14			20	..	
	21	0·03			2	..	
	22	0·08			22	0·02	
	23	0·12			23	0·05	
	24	..			24	0·02	
	25	..			25	0·07	
	26	..			26	0·03	
	27	..			27	0·01	
	28	0·07			28	0·04	
	29	0·01			29	0·01	
	30	0·05			30	..	
	31	0·06					
Total Rain-fall, . . . **1·44** inches.				Total Rain-fall, . . **0·32** of an inch.			

LADDER-HILL, ST. HELENA.

Month.	Date.	Rain.	Remarks.	Month.	Date.	Rain.	Remarks.
DECEMBER, 1863.	1	0·05	Recorded by Major Phillipps, R. A.	JANUARY, 1864.	1	0·02	Recorded by Major Phillipps, R. A.
	2	0·09			2	0·04	
	3	. .			3	0·06	
	4	. .			4	0·03	
	5	0·02			5	0·02	
	6	. .			6	0·02	
	7	0·04			7	0·01	
	8	0·01			8	0·02	
	9	. .			9	. .	
	10	. .			10	0·01	
	11	0·04			11	0·02	
	12	0·01				. .	
	13	0·02			13	0·05	
	14	. .			14	0·11	
	15	. .			15	0·05	
	16	0·04			16	. .	
	17	. .			17	0·05	
	18	. .			18	0·03	
	19	. .			19	. .	
	20	. .			20	0·02	
	21	. .			21	. .	
	22	. .			22	. .	
	23	. .			23	. .	
	24	. .			24	. .	
	25	. .			25	. .	
	26	0·06			26	0·02	
	27	0·04			27	0·01	
	28	0·02			28	0·09	
	29	0·04			29	0·06	
	30	0·10			30	0·09	
	31	. .			31	0·06	
Total Rain-fall . . 0·56 of an inch.				Total Rain-fall, . . 0·89 of an inch.			

LADDER HILL, ST. HELENA.

Month.	Date.	Rain.	Remarks.
FEBRUARY, 1864.	1	0·02	Recorded by Major PHILLIPPS, R. A.
	2	0·01	
	3	0·01	
	4	0·13	
	5	0·18	
	6	0·03	
	7	..	
	8	0·01	
	9	..	
	10	0·02	
	11	0·01	
	12	0·03	
	13	0·06	
	14	0·02	
	15	0·03	
	16	0·01	
	17	0·03	
	18	0·12	
	19	0·04	
	20	0·14	
	21	..	
	22	..	
	23	0·04	
	24	0·08	
	25	0·17	
	26	0·04	
	27	0·01	
	28	0·08	
	29	0·10	

Total Rain-fall, . . . 1·42 inches.

Month.	Date.	Rain.	Remarks.
MARCH, 1864.	1	0·12	Recorded by Major PHILLIPPS, R. A.
	2	0·18	
	3	..	
	4	0·05	
	5	0·18	
	6	0·08	
	7	0·09	
	8	0·08	
	9	0·06	
	10	..	
	11	..	
	12	..	
	13	0·02	
	14	..	
	15	..	
	16	..	
	17	0·02	
	18	0·07	
	19	0·17	
	20	0·01	
	21	0·04	
	22	..	
	23	..	
	24	..	
	25	..	
	26	..	
	27	..	
	28	..	
	29	0·09	
	30	0·02	
	31	0·04	

Total Rain-fall, . . 1·22 inches.

LADDER HILL, ST. HELENA.

Month.	Date.	Rain.	Remarks.
APRIL, 1864.	1	0·02	Recorded by Major PHILLIPPS, R. A.
	2	0·08	
	3	0·03	
	4	. .	
	5	. .	
	6	0·03	
	7	0·17	
	8	0·10	
	9	0·23	
	10	0·18	
	11	0·22	
	12	0·14	
	13	0·09	
	14	0·04	
	15	0·13	
	16	0·06	
	17	0·08	
	18	0·04	
	19	0·03	
	20	0·03	
	21	. .	
	22	. .	
	23	. .	
	24	0·02	
	25	. .	
	26	. .	
	27	0·02	
	28	. .	
	29	0·01	
	30	. .	
Total Rain-fall, . . 1·77 inches.			

Month.	Date.	Rain.	Remarks.
MAY, 1864.	1	. .	Recorded by Major PHILLIPPS, R. A.
	2	. .	
	3	. .	
	4	. .	
	5	. .	
	6	. .	
	7	0·12	
	8	0·26	
	9	0·29	
	10	0·17	
	11	0·21	
	12	. .	
	13	. .	
	14	0·38	
	15	0·07	
	16	. .	
	17	. .	
	18	0·16	
	19	0·22	
	20	0·37	
	21	0·11	
	22	. .	
	23	. .	
	24	. .	
	25	. .	
	26	. .	
	27	. .	
	28	. .	
	29	. .	
	30	0·03	
	31	. .	
Total Rain-fall, . . 2·39 inches.			

LADDER HILL, ST. HELENA.

Month.	Date.	Rain.	Remarks.
JUNE, 1864.	1	0·08	Recorded by Major PHILLIPPS, R. A.
	2	0·06	
	3	0·32	
	4	0·20	
	5	0·03	
	6	. .	
	7	. .	
	8	. .	
	9	. .	
	10	. .	
	11	. .	
	12	. .	
	13	. .	
	14	0·31	
	15	0·37	
	16	0·14	
	17	0·19	
	18	0·16	
	19	0·18	
	20	0·14	
	21	. .	
	22	. .	
	23	0·03	
	24	0·15	
	25	0·09	
	26	. .	
	27	0·15	
	28	0·26	
	29	0·04	
	30	. .	
Total Rain-fall, . . 2·90 inches.			

Month.	Date.	Rain.	Remarks.
JULY, 1864.	1	. .	Recorded by Major PHILLIPPS, R. A.
	2	. .	
	3	. .	
	4	. .	
	5	0·10	
	6	. .	
	7	. .	
	8	0·05	
	9	. .	
	10	. .	
	11	. .	
	12	0·02	
	13	. .	
	14	. .	
	15	. .	
	16	0·14	
	17	0·06	
	18	. .	
	19	0·09	
	20	0·08	
	21	0·03	
	22	0·09	
	23	0·04	
	24	0·05	
	25	0·11	
	26	0·30	
	27	0·29	
	28	0·11	
	29	0·02	
	30	. .	
	31	. .	
Total Rain-fall, . . 1·58 inches.			

LADDER HILL, ST. HELENA.

Month.	Date.	Rain.	Remarks.
AUGUST, 1864.	1	0·06	Recorded by Major Phillipps, R. A.
	2	0·03	
	3	0·02	
	4	0·05	
	5	0·44	
	6	0·42	
	7	0·15	
	8	0·27	
	9	..	
	10	.	
	11	..	
	12	..	
	13	0·06	
	14	..	
	15	..	
	16	0·03	
	17	0·12	
	18	..	
	19	..	
	20	..	
	21	..	
	22	0·12	
	23	0·06	
	24	0·04	
	25	..	
	26	0·03	
	27	..	
	28	..	
	29	..	
	30	0·02	
	31	..	

Total Rain-fall, . . **1·92** inches.

Month.	Date.	Rain.	Remarks.
SEPTEMBER, 1864.	1	..	Recorded by Major Phillipps, R. A.
	2	..	
	3	0·05	
	4	..	
	5	0·02	
	6	..	
	7	0·04	
	8	0·08	
	9	0·10	
	10	0·04	
	11	0·05	
	12	0·15	
	13	0·21	
	14	0·18	
	15	0·07	
	16	0·08	
	17	0·04	
	18	..	
	19	..	
	20	0·02	
	21	..	
	22	..	
	23	0·03	
	24	..	
	25	0·06	
	26	0·05	
	27	..	
	28	..	
	29	..	
	30	..	

Total Rain-fall, . . **1·27** inches.

LADDER HILL, ST. HELENA.

Month.	Date.	Rain.	Remarks.
OCTOBER, 1864.	1	. .	Recorded by Major PHILLIPPS, R. A.
	2		
	3	. .	
	4	. .	
	5	. .	
	6	. .	
	7	. .	
	8	. .	
	9	. .	
	10	. .	
	11	. .	
	12	. .	
	13	. .	
	14	0·06	
	15	0·05	
	16	0·03	
	17	. .	
	18	. .	
	19	0·05	
	20	0·02	
	21	0·04	
	22	0·02	
	23	0·02	
	24	0·03	
	25	. .	
	26	. .	
	27	. .	
	28	. .	
	29	0·02	
	30	. .	
	31	. .	

Total Rain-fall, . . 0·34 of an inch.

Month.	Date.	Rain.	Remarks.
NOVEMBER, 1864.	1	. .	Recorded by Major PHILLIPPS, R. A.
	2	. .	
	3	. .	
	4	. .	
	5	. .	
	6	0·08	
	7	. .	
	8	. .	
	9	. .	
	10	0·02	
	11	0·03	
	12	0·04	
	13	. .	
	14	. .	
	15	. .	
	16	. .	
	17	. .	
	18	. .	
	19	0·02	
	20	0·02	
	21	. .	
	22	. .	
	23	. .	
	24	0·02	
	25	. .	
	26	. .	
	27	. .	
	28	. .	
	29	0·05	
	30	0·06	

Total Rain-fall, . . 0·34 of an inch.

LADDER HILL, ST. HELENA.

Month.	Date.	Rain.	Month.	Date.	Rain.	Remarks.
DECEMBER, 1864.	1	0·05	DECEMBER, 1864—*continued.*	17	. .	Recorded by Major PHILLIPPS, R. A.
	2	0·03		18	. .	
	3	0·06		19	. .	
	4	0·05		20	. .	
	5	0·15		21	. .	
	6	0·04		22	. .	
	7	. .		23	. .	
	8	0·05		24	0·02	
	9	0·10		25	. .	
	10	0·15		26	. .	
	11	. .		27	. .	
	12	0·04		28	0·02	
	13	0·03		29	0·03	
	14	. .		30	0·05	
	15	. .		31	. .	
	16	. .				

Total Rain-fall, . . . 0·87 of an inch.

In the following Table I have collected together, in the form of an abstract, the preceding Observations on Evaporation and Rain-fall, week by week.

The column marked *E – R* denotes Evaporation minus Rain-fall for each week, observed in the cylinder surrounded by water; the column *R* denotes the weekly Rain-fall; and the column *E* denotes the Evaporation, deduced from the preceding.

	Date.	*E – R.*	*R.*	*E.*		Date.	*E – R.*	*R.*	*E.*
1862.	Aug. 10	1·00	0·48	1·48	1863.	April 5	1·75	0·05	1·80
	„ 17	1·50	0·15	1·65		„ 12	0·90	0·83	1·73
	„ 24	1·00	0·07	1·07		„ 19	1·25	0·72	1·97
	„ 31	1·20	0·21	1·41		„ 26	1 35	0·17	1·52
	Sept. 7	1·50	0·02	1·52		May 3	1 85	0·03	1·88
	„ 14	1·80	0·06	1·86		„ 10	1·75	0·00	1·75
	„ 21	1·50	0·26	1·76		„ 17	1·70	0·01	1·71
	„ 28	1·10	0·20	1·30		„ 24	1·65	0·00	1·65
	Oct. 5	1·60	0·11	1·71		„ 31	1·25	0·38	1·63
	„ 12	1·60	0·34	1·94		June 7	1·30	0·09	1·39
	„ 19	1·40	0·51	1·91		„ 14	1·05	0·14	1·19
	„ 26	1·60	0·01	1·61		„ 21	0·00	2·16	2·16
	Nov. 2	1·60	0·00	1·60		„ 28	– 0·20	1·29	1·09
	„ 9	1·35	0·02	1·37		July 5	0·70	0·88	1 23]
	„ 16	2·10	0·26	[1·31]*		„ 12		1·25	[1·60]
	„ 23		0·23	[1·28]		„ 19	1·00	0·48	[1·48
	Dec. 7	1·55	0·17	1·72		„ 26	0·40	0·86	1 26
	„ 14	1·60	0·03	1·68		Aug. 2	1·20	0·20	1·40
	„ 21	1·45	0·00	1·45		„ 9	1·35	0·01	1·36
	„ 28	1·55	0·24	1·74		„ 16	1·30	0·16	1·46
1863.	Jan. 4	1·55	·0·08	1·63		„ 23	1·10	0·53	1·63
	„ 11	1·65	0·07	1·72		„ 30	1·00	0·11	1·11
	„ 18	1·10	0·28	1·38		Sept. 6	0·70	0 50	1·20
	„ 25	1·30	0·16	1·46		„ 13	1·20	0·14	1·34
	Feb. 1	1·55	0·20	1·75		„ 20	1·20	0·10	1·30
	„ 8	1·40	0·27	1·67		„ 27	0·80	0·43	1 23
	„ 15	0·90	1·24	2·14		Oct. 4	1·10	0·57	1·67
	„ 22	1·40	0·40	1·80		„ 11	1·30	0·26	1·56
	Mar. 1	1·40	0·69	2·09		„ 18	1·70	0·18	1·88
	„ 8	1·00	0·72	1·72		„ 25	1·10	0·44	1·54
	„ 15	2·00	1·90	[2·90]		Nov. 1	1·40	0·20	1·60
	„ 22		0·28	[1·28]		„ 8	1·70	0·01	1·71
	„ 29	1·80	0 18	1·98		„ 15	1·75	0·02	1·77

* When two or three weeks are recorded together, the means are used, and such results are entered between brackets [ ].

	Date.	*E* - *R*.	*R*.	*E*.		Date.	*E* - *R*.	*R*.	*E*.
1863.	Nov. 22	1·55	0·05	1·60*	1864.	June 19	0·55	1·35	1·90
	,, 29	—	0·23	[1·67]		,, 26	0·90	0·41	1·31
	Dec. 6	1·60	0·14	1·74		July 3	0·80	0·45	1·25
	,, 13	1·50	0·12	1·62		,, 10	1·10	0·15	1·25
	,, 20	1·75	0·04	1·79		,, 17	1·25	0·22	1·47
	,, 27	3·86	0·10	[1·39]		,, 24	1·05	0·38	1·43
1864.	Jan. 3		0·28	[1·56]		,, 31	1·10	0·83	[1·38]
	,, 10		0·11	[1·40]		Aug. 7		1·17	[1·72]
	,, 17	1·37	0·28	1·65		,, 14	0·85	0·33	1·18
	,, 24	1·65	0·05	1·83		,, 21	1·25	0·15	1·40
	,, 31	1·50	0·37	1·63		,, 28	1·05	0·25	1·30
	Feb. 7	1·25	0·38	1·90		Sept. 4	1·10	0·07	1·17
	,, 14	1·75	0·15	1·52		,, 11	1·40	0·33	1·73
	,, 21	1·15	0·37	2·02		,, 18	0·80	0·73	1·53
	,, 28	1·60	0·42	1·91		,, 25	1·40	0·11	1·51
	Mar. 6	1·25	0·66	1·85		Oct. 2	1·30	0·05	1·35
	,, 13	1·65	0·20	1·62		,, 9	1·45	0·00	1·45
	,, 20	1·35	0·27	1·84		,, 16	1·45	0·14	1·59
	,, 27	1·80	0·04	1·98		,, 23	1·60	0·15	1·75
	April 3	1·70	0·28	1·91		,, 30	2·70	0·05	[1·40]
	,, 10	1·20	0·71	1·66		Nov. 6		0·08	[1·43]
	,, 17	0·90	0·76	1·62		,, 13	2·50	0·09	[1·34]
	,, 24	1·50	0·12	1·63		,, 20		0·04	[1·29]
	May 1	1·60	0·03	1·83		,, 27	1·70	0·02	1·72
	,, 8	1·45	0·38	1·37		Dec. 4	1·00	0·30	1·30
	,, 15	0·25	1·12	1·61		,, 11	1·02	0·49	1·51
	,, 22	0·75	0·86	1·30		,, 18	1·60	0·07	1·67
	,, 29	1·30	0·00	[1·79]		,, 25	1·50	0·02	1·52
	June 5	2·10	0·00	[1·05]					
	,, 12								

If we combine the preceding results into periods of four weeks, commencing at winter solstice (summer in Southern hemisphere), we find the following Table, containing the thirteen lunar months of each year:—

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* The entries in brackets [ ] are deduced from those before and after them, or are means, when several weeks are recorded together.

TABLE *showing Evaporation for Periods of Four Weeks.*

Lunar Month.	Commencing December 22, 1862.	Commencing December 21, 1863.	Commencing December 20, 1864.	Mean.
	Inches.	Inches.	Inches.	Inches.
1	. .	6·47	6·00	6·23
2	. .	7·02	7·06	7·04
3	. .	8·51	7·30	7·90
4	. .	6·79	7·35	7·07
5	. .	7·12	6·74	6·93
6	. .	6·38	6·07	6·22
7	. .	5·67	5·51	5·59
8	. .	5·74	5·53	5·63
9	. .	5·56	5·60	5 58
10	6·55	5·07	5·94	5 85
11	6·86	6·65	6·14	6·55
12	5·89	6·68	5·46	6·01
13	6·13	6·82	6·20	6·38
Total, . .		**84·48**	**80·90**	**82·98**

The last column of this Table is shown graphically in Plate I., and proves that the maximum and minimum of Evaporation follow the solstice by intervals different in summer and winter; the maximum occurring three months after, or nearly at the time of the equinox, and the minimum occurring one month and a half after its own solstice. This result differs from that formerly found for Dublin, where the maximum and minimum of Evaporation coincide very nearly with the times of the solstices themselves.

This difference is produced by causes not difficult of detection.

XVII.—Notes on Animal Mechanics. By the Rev. Samuel Haughton, M. D., Fellow of Trinity College, Dublin.

[Read before the Royal Irish Academy, June 26, 1865.]

No. VI.—*On the Muscular Anatomy of the Crocodile.*

During the Easter Recess of 1864, I had an opportunity of explaining to Professor Gratiolet,* of Paris, the investigations I had made with respect to the mechanism of the leg of the Ostrich and the theory I had formed to explain it. This distinguished anatomist did me the honour of approving of my explanation, and urged me to procure a Crocodile, in the posterior limb of which he assured me I should find a mechanical problem exceeding in complexity that presented by the leg of the Ostrich, and as yet unsolved by anatomists.

During the month of March last I was furnished with a young Crocodile from Egypt, by Mr. Thomas Moore, Curator of the Derby Museum, Liverpool, to whom I had communicated my earnest desire to have an opportunity of dissecting such an animal; and the results of my examination fully bear out the anticipation of Professor Gratiolet, and also furnish a complete confirmation of the principles I made use of in my theory of the leg of the Ostrich.

The interlacing of tendons in the hind leg of the Crocodile is very remarkable, and more complex than in the Ostrich, although in one respect it somewhat resembles it.

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* The incalculable loss that science has sustained in the early part of the present year by the premature death of this gifted anatomist, is exceeded by the loss experienced by his friends, to whom his genial social qualities endeared him even more than his brilliant scientific attainments. I extract from the "Journal des Debats" of the 19th February, 1865, the following just tribute to his memory:—

"Les sciences viennent de faire une perte aussi cruelle qu'imprévue; M. Gratiolet, professeur de zoologie à la Faculté des Sciences de Paris, a succombé hier matin à une attaque d'apoplexie.

"M. Gratiolet n'avait pas cinquante ans; avant-hier, encore plein de vie et de santé, il travaillait à son laboratoire du Muséum d'histoire naturelle lorsque, à deux heures, frappé d'une congestion subite, il dut être ramené à son domicile; quelques heures plus tard, il avait perdu connaissance; hier matin à quatre heures, il rendait le dernier soupir.

"Nous ne saurions peindre l'émotion profonde qu'a causée dans le monde scientifique l'annonce de cette mort prématurée. M. Gratiolet était aimé de tous; son affabilité, la droiture de son caractère lui avaient concilié toutes les sympathies.

"Ses travaux d'anatomie comparée, ses recherches sur le système nerveux et sur le cerveau, etc., l'avaient mis au nombre des naturalistes les plus distingués de notre pays; son merveilleux talent d'élocution l'avait placé au premier rang parmi nos professeurs les plus renommés, et l'aptitude de son esprit pour les études métaphysiques avait imprimé à ses œuvres un caractère d'originalité qu'appréciaient les philosophes aussi bien que les savans.

"La mort est venue le frapper au moment où, après de longues années de lutte, il semblait sur le point de recueillir le fruit de ses laborieux efforts.

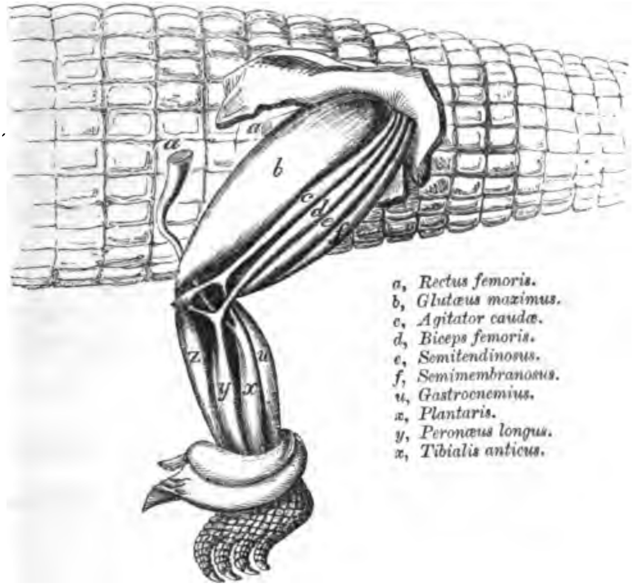
"Aimé Girard."

PART I.—DISSECTION OF LEG OF CROCODILE.

On removing the skin and dissecting away the fat, the muscles shown in Fig. 19 are exposed.

Fig. 19.

LEFT LEG OF CROCODILE (with skin removed, to show the superficial muscles).



1. *M. Glutæus maximus* (*b*), ... 0·15 oz.
   Origin; from central half of the ilio-ischiadic line.
   Insertion; into the fascia outside and above the knee joint.

This is a broad flat muscle, and straps down the tendon of the ***rectus femoris*** in its passage over the knee.

2. ***M. rectus femoris*** (*a*), ... 0·08 oz.
   Origin; from anterior spine of the ilium, close to the acetabulum.
   Insertion; as in the leg of the Ostrich, into a tendon passing over the knee outwards, and terminating in a remarkable muscle* (*x*), in the calf of the leg, associated with the ***gastrocnemius*** (*u*), and deriving a second origin from the ***agitator caudæ*** (*c*), as shown in the figure.

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* This muscle may be the ***plantaris***.

3. *M. agitator caudæ* (*c*), ... 0·03 oz.
Origin; from the ischiadic line, behind the *glutæus maximus.*
Insertion; by a double tendon.

1. One tendon passes through a pulley on the outside of the knee, formed by the tendon of the *biceps* (*d*) as it passes to its fibular insertion, and is then inserted in the head of the muscle (*x*), in the calf of the leg.

2. The second insertion is by means of a tendon that goes to the top and front of the tibia; this second tendon also serves to strap down the tendon of the *rectus femoris* (*a*).

4. *M. biceps femoris* (*d*), ... 0·05 oz.
Origin; from the ilioischium, under and behind the origin of the *glutæus maximus.*
Insertion; partly into the top of the fibula, forming a pulley for the *agitator caudæ* (*c*), and an additional strap for the *rectus femoris* (*a*); and partly by means of another tendon into the head of the *peronæus longus* (*y*).

5. *M. semitendinosus* (*e*), ... 0·18 oz.
Origin; from the posterior point of the tuber ischii.
Insertion; by a remarkable looped tendon, having one end inserted into the back of lower end of femur, and the other end into the os calcis.

6. *M. semimembranosus* (*f*), ... 0·11 oz.
Origin; tuber ischii.
Insertion; into the top of the tibia, by a tendon common to this muscle and *gracilis.*

The muscles of the calf shown in the figure are the following:—

7. *M. gastrocnemius* (*u*), ... 0·14 oz.
This muscle, as usual, has an outer and inner head.

Outer head, ... 0·11 oz.
Origin; from the tendon of the great caudal extensor of the thigh, half an inch from its insertion into the outer condyle (vide *a*, Fig. 20).
Insertion; into the under side of the outer tarsal bone, and into the plantar fascia.

Inner head, ... 0·03 oz.
Origin; from the top of fibula and inner condyle of femur.
Insertion; by a tendon, which unites with that of the outer head before reaching the os calcis, under which it passes to be inserted into the outer and under side of the outer tarsal bone.

8. *M. plantaris ?* (*x*), ... 0·04 oz.
Origin; double; from *rectus femoris* and from *agitator caudæ.*
Insertion; having become partially blended with the outer *gastrocnemius*, it is inserted into the os calcis, and under surface of the plantar fascia.

9. *M. peronæus longus* (*y*), ... 0·03 oz.

Origin; from the shaft of the fibula, and from the tendon of the biceps femoris (*d*).

Insertion; into the outer tarsal bone, uniting with the tendon of the *gastrocnemius*.

10. *MM. tibialis anticus et extensor digitorum communis* (*z*), . 0·11 oz.

Insertion; into the tarsal end of the 1st, 2nd, and 3rd metatarsal bones.

The interlacing of muscles in the thigh and leg of the Crocodile, just described, is very remarkable, and more complicated than that found even in the Ostrich; and at first I was disposed to think that it threw some doubt on the explanation I had given previously of the reason for such an arrangement in the bird's leg. In the case of the Ostrich the necessity for strict simultaneity of action was made evident by the great force of the muscles employed, and the great delicacy of the bones on which they had to act. What could there be in the case of the Crocodile to correspond to such a peculiarity in the case of the Ostrich? After some careful dissection I found the ready answer to my question in the remarkable muscle which I shall now describe.

On clearing away the superficial muscles of the thigh and tail, I found the enormous mass of muscle, figured at *b*, Fig. (20), which acts as the chief and powerful extensor of the thigh.

11. *M. extensor femoris caudalis* (*b*),* . . . . 1·81 oz.

Origin; from the transverse and inferior spinous processes of the caudal vertebræ, from the 3rd to the 15th, inclusive.

Insertion; into the back of the upper part of the femur, and into a great round tendon, which receives, in particular, the anterior fibres of this enormous muscle, and, passing down the back of the femur, is inserted by a strong common aponeurosis into the outer condyle of the femur, and into the head of the fibula. This common aponeurosis also gives a partial origin to the *gastrocnemius* (*a*), Fig. 20, and to the *plantaris* (*x*), Fig. 19.

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* This remarkable muscle is noticed and accurately described by Meckel, in tome iii., pp. 152, 153, of his "System der vergleichenden Anatomie" (Halle, 1828); but it is very strange that he transposes its origin and insertion, and seems not to have had any idea of its real use. It is regarded from his point of view as a descriptive anatomist, and without the remotest reference to its final cause. He says:—"Der zweite, tiefere weit dickere Muskkel is von dem ersten [the superficial muscle of the tail] wie einer breiten Binde umgeben, entspringt mit zwei ganz getrennten, 1) einer weit kürzern, breiten Sehne oben von den hintern Fläche des Oberschenkelbeines; 2) durch eine weit längere, schlanke, unten zwischen den beiden Gelenkknorren desselben Knockens, und setzt sich an die ganze Seitenfläche der untern Dornen, so wie der Zwischendornenhaut und die untere Fläche der Wurzeln der Querfortsätze."

There are two muscles, accessory to this great caudal extensor in their action, which are as follows:—

12. ***M. extensori femoris caudali accessorius***, . . 0·01 oz.
   Origin; from the fascia covering the great caudal extensor, and by a tendinous head from the *quadratus femoris*, which is also an accessory to the great caudal.
   Insertion; into the looped tendon of the *semimembranosus*, already described.

13. ***M. quadratus femoris***, 0·05 oz.
   Origin; posterior, superior, and inner surface of the pubis, near its symphysis.
   Insertion; into the back of the femur, with the action and position of the *quadratus femoris* in mammal quadrupeds, and into the tendon of the great caudal extensor.

The effect of the interlacing of the tendons of the various muscles already described must be to produce simultaneity of action among them, such as I have already endeavoured to describe in my account of the leg of the Ostrich; and in the present instance of the Crocodile there seems to be a similar principle involved. The Crocodile, resting on mud, progresses chiefly by using his hind feet as paddles; and in this use of them the great caudal extensor of the thigh is the most pow-

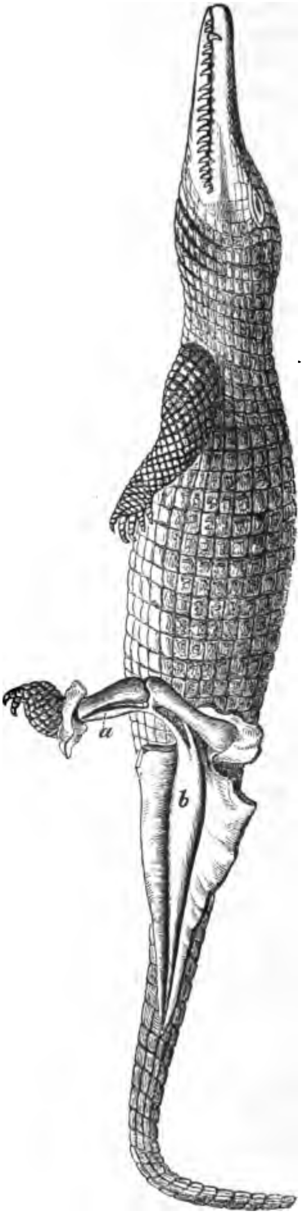


Fig. 20.

Common Crocodile of Egypt (with superficial muscles removed, to show the great deep flexor of the thigh).

a, *Gastrocnemius*. *b*, *Extensor femoris caudalis*.

erful and important muscle employed; and it seems to me that the simultaneity of action of all parts of the leg, rendered necessary by the employment of so powerful a muscle, is fully secured by the interlacing of the tendons I have described, which renders it impossible for one set of muscles to act without the others being also exerted.

The remaining muscles of the posterior limb are as follows:—

14. *M. glutæus medius*, ... 0·06 oz.
Origin; from the central part of the ilio-ischiadic surface.
Insertion; its tendon passes over the great trochanter to be inserted into a line down the upper half of the outside of the femur, between the origins of the two portions of the *vastus externus*.

15. *M. Glutæus minimus*, ... 0·02 oz.
Origin; from the anterior point of the ilium.
Insertion, into the inner side of the knee, under the fascia of the *rectus femoris*.

16. *MM. vastus internus, externus, et cruræus*, ... 0·22 oz.
The *vastus externus* consists of two distinct muscles, as in the Ostrich.

17. *M. psoas*, ... 0·57 oz.
This large muscle takes an origin as high as the last rib, and is inserted into the lesser trochanter, and the intertrochanteric line leading to the outer side of the femur. It lies outside the *iliacus*.

18. *M. iliacus*, ... 0·11 oz.
Origin; from the anterior transverse surface of the ilium, with a slip from the spine.
Insertion; altogether into the lesser trochanter.

19. *M. sartorius*, ... 0·04 oz.
Origin; behind the origin of the *rectus*, on the inner side, at the junction of the ilium and marsupial bone.
Insertion; into the fascia of the inner side of the thigh, for two-thirds of its length.

20. *M. gracilis*, ... 0·08 oz.
Takes an origin from two heads—one at the posterior point of the pubis, and the other on the pectinæal line.
Insertion; into the head of the tibia by a tendon common to it with the *semimembranosus*.

21. *M. pectinæus*, ... 0·06 oz.
Origin; between the two heads of *gracilis*, from the central part of the surface of the pubis and from the pectinæal line.
Insertion, into the top of the linea aspera.

22. *MM. adductores*, ... 0·21 oz.

There are three adductor muscles:—
1st *Adductor*, ... 0·13 oz.

Origin; anterior pectinæal line of pubis.
Insertion; into the upper half of the linea aspera.

2nd *Adductor*, ... 0·03 oz.
Origin; from the posterior edge of the pubis, its middle third.
Insertion; into the middle of the linea aspera.

3rd *Adductor*, ... 0·05 oz.
Origin; from the posterior edge of the pubis, close to the symphysis.
Insertion; into the back of the top of the fibula, with a fascial union with the tendon of the *semitendinosus*.

23. *M. obturator externus?* . . . . 0·13 oz.
Origin; from the tuber ischii, the posterior edge of the ischium, and the obturator membrane.
Insertion; into an oblique line on the back of the femur, below the insertion of the *quadratus femoris*.

24. *M. marsupialis externus*, ... 0·07 oz.
25. *M. marsupialis internus*, ... 0·10 oz.
These two muscles take their origin, respectively, from the outer surface of the marsupial bone, and from its inner surface and the last abdominal rib; and they are inserted by a common tendon into the top of the posterior intertrochanteric line. Their action is to rotate the femur directly inwards.

26. *M. flexor proprius hallucis*, ... 0·02 oz.
Origin; from the outer condyle of femur.
Insertion; into the first, second, and third toes.

27. *M. flexor digitorum communis*, ... 0·05 oz.
Origin; from the fibula and tibia.
Insertion; into the first, second, and third toes.

28. *M. tibialis posticus*, ... 0·06 oz.
This muscle is inserted into the tarsal ends of the first, second, and third metatarsal bones.

29. *M. peronæo-calcaneus*, ... 0·01 oz.
Origin; from the lower part of the shaft of the fibula.
Insertion; into the upper surface of the calcaneum.

PART 2.—DISSECTION OF ARM OF CROCODILE.

The muscular anatomy of the anterior limb of the Crocodile presents no such remarkable peculiarities as those I have described in the leg, and therefore a rapid enumeration of its muscles will be sufficient. It is necessary to bear in mind, for the purpose of comparison with the muscles of the leg, that

The Marsupial bone represents the clavicle;
,, Pubis, ,, ,, coracoid;
,, Ilium, ,, ,, acromion;
,, Ischium, ,, ,, scapula.

1. *M. trapezius*, ... 0·10 oz.
   Origin; from the occipital and cervical scutes, as far back as the shoulder joint.
   Insertion; into the anterior edge of the acromion.
2. *M. latissimus dorsi* (*humerodorsalis*), ... 0·12 oz.
   Origin; from the four anterior dorsal scutes.
   Insertion; into the back of the humerus, having its tendon conjoined with that of the *teres major*.
3. *M. teres major*, ... 0·02 oz.
   Origin; posterior superior portion of scapula.
   Insertion; with *latissimus dorsi.*
4. *M. sterno-atlanticus*, ... 0·22 oz.
   Origin; from the sternum, in front of its articulation with the coracoid.
   Insertion; into the side of the atlas.
5. *M. pectoralis major*, ... 0·77 oz.
   Origin; from top of sternum, and its entire length, and from the abdominal ribs two-thirds of the distance to the pelvis.
   Insertion; into the outer edge of the great pectoral ridge of the humerus.
6. *M. pectoralis minor*, ... 0·04 oz.
   Origin; from the outer surface of the acromion and coracoid, lying under the tendon of the *biceps humeri.*
   Insertion; inner side of pectoral ridge.

   In this muscle is also included the *supraspinatus*, which is represented by the portion of the muscle taking its origin from the scapular border of the acromion, inside the origin of the deltoid. These two pectorals draw the arm forward in swimming.
7. *M. pectoralis secundus*, ... 0·04 oz.
   Origin; from the first sternal rib.
   Insertion; into the posterior edge of the coracoid.

   This muscle draws the arm backwards, by acting on the coracoid, and may represent the second pectoral of birds.
8. *M. sternomastoideus*, ... 0·17 oz.
   Origin; from top of sternum.
   Insertion; into the posterior third of inner side of lower jaw.
9. *M. Omo-hyoideus*, ... 0·06 oz.
   Origin; from the acromion, just above the glenoid cavity.
   Insertion; into the descending wing of the hyoid bone.
10. *M. deltoideus*, ... 0·15 oz.
   Origin; from a broad rim of the acromion, and from the inner surface of the acromion, winding out over the edge to form the inner portion of the deltoid.
   Insertion; into the deltoid ridge of the humerus.
11. *M. infraspinatus*, ... 0·02 oz.
   Origin; from the outer surface of the scapula, which is altogether occupied by this muscle and the *teres major*.

Insertion; by a long tendon into the greater tuberosity.

12. *M. rhomboideus*, ... 0·02 oz.
Origin; from spinous processes of the last cervical and the first dorsal vertebra.
Insertion; under surface of vertebral edge of scapula.

13. *M. serratus magnus*, ... 0·26 oz.
Origin; from the transverse processes of the vertebræ, from 2nd to 8th, inclusive.
Insertion; all round the edge of acromion, and anterior and vertebral edge of the scapula.

This muscle is continuous with the next, which may be regarded as equivalent to the scapulocostal *latissimus dorsi* muscle found in the Seal.

14. *M. latissimus dorsi scapulocostalis*, ... 0·15 oz.
Origin; from the ribs of the 9th to 14th vertebræ, inclusive.
Insertion; into the posterior edge of the scapula.

15. *M. triceps*, ... 0·25 oz.
Origin, threefold:—

1. From the posterior edge of the scapula, near the glenoid;
2. By a bifurcate tendon from the coracoid and scapula, allowing the *subscapularis* to pass between the two tendons.
3. From the outer and inner surfaces of the back of the humerus.

16. *M. subscapularis*, ... 0·05 oz.
Origin; from the inner surface and anterior edge of the scapula.
Insertion; into the lesser tuberosity, and into the line leading from it down the inner side of the arm.

17. *M. biceps humeri*, ... 0·03 oz.
Origin; from the inner side of the anterior edge of the coracoid, in front of the glenoid.
Insertion; into the radius.

18. *M. brachialis externus*, ... 0·03 oz.
Origin; from the line outside and below the pectoral ridge.
Insertion; into the radius, outside the insertion of the *biceps*, the tendon of the *brachialis anticus* lying between them.

19. *M. brachialis anticus*, ... 0·02 oz.

This muscle is inserted into the radius, between the insertions of the *biceps* and *brachialis externus*.

20. *M. extensor carpi radialis*, ... 0·01 oz.
21. *M. supinator radii longus*, ... 0·02 oz.
22. *M. extensor digitorum communis*, ... 0·01 oz.
23. *M. anconæus*, ... 0·01 oz.
Origin; from the outer condyle of the humerus.
Insertion; into the ulna, along the whole length of its outer side.

24. *M. extensor carpi*, ... 0·04 oz.
Origin, from the radius and ulna, and from the interosseous septum.
Insertion; into the middle carpal bone.

25. *M. pronator radii*, ...	0·03 oz.

Origin; from the inner condyle of the humerus.
Insertion; into the whole length of the radius.

26. *M. flexor carpi ulnaris*, ...	0·03 oz.

Origin; from the inner condyle.
Insertion; into the outer carpal bone, articulating with the ulna.

27. *M. palmaris* (?), ...	0·01 oz.

Origin; from the inner condyle.
Insertion; into the tendon of the *flexor digitorum communis* in the centre of the palm. Its force is expended on the index and middle fingers.

28. *M. flexor digitorum communis*, ...	0·03 oz.

Origin; from the whole inner surface of the ulna.
Insertion; into the ungual phalanges of the thumb, index, and middle fingers.

There are, in addition, short flexors in the palm, terminating in the metacarpal ends of the phalanges at each side, allowing the tendon of the long flexor to pass through.

The ring and little fingers seem to be flexed altogether by these palmar tendons.

XVIII.—NOTES ON ANIMAL MECHANICS. By the Rev. SAMUEL HAUGHTON, M. D., Fellow of Trinity College, Dublin.

[Read before the Royal Irish Academy, June 26, 1865.]

No. VII.—*On the Muscular Anatomy of the Macacus nemestrinus.*

THE first monkey which I shall describe in this Note was a very fine specimen of *Macacus nemestrinus*, which died, after a short illness, in January of the present year, of tubercular disease affecting the liver, spleen, and other organs. He had previously suffered from rheumatic arthritis of both knee joints, which had destroyed the anterior surfaces of the outer condyles of the femur, and so caused dislocation of both patellas outwards.

On examination after death, the following observations were made:—

1. *Lungs*; both filled with miliary tubercle.
2. *Heart*; exhibited two specks of tubercle, similar to those met with in the lungs.
3. *Liver*; divided into five lobes, of which four were filled with tubercular nodules, and the fifth was wholly converted into a cheesy tuberculous mass.
4. *Spleen*; contained several large nodules of softened tubercle.
5. *Glands*; of mesentery, united into one tubercular mass; of thoracic spinal region, somewhat affected; of lumbar region, healthy.

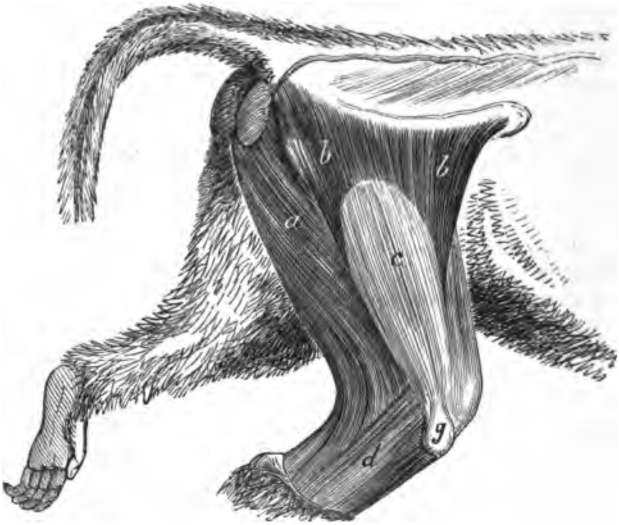
Weight of dead body, ...	26 lbs.

Muscles of Leg and Foot.

1. *MM. agitator caudæ, glutæus maximus, tensor vaginæ femoris* (Fig. 21, *b b*), ... 0·90 oz.

Fig. 21.*

HIND LEG OF MACACUS NEMESTRINUS
(with skin removed).



a,	*Biceps femoris.*	*c,*	Great fascia of thigh.
b b,	Combined *agitator caudæ, glutæus maximus,* and *tensor vaginæ femoris.*	*d,*	Outer portion of *gastrocnemius.*
		g,	Displaced patella of right knee.

These three muscles form one continuous sheet of fibres, expanded over the upper and outer portion of the thigh; they are shown at *b b*, Fig. 21.

The *agitator caudæ* forms the posterior portion of the entire muscle, and takes its origin from the first and second caudal vertebræ; the *tensor vaginæ* corresponds to the *agitator* in front of the muscle, and arises from the crest of the ilium; and the smallest, or central portion, is composed of the *glutæus maximus* proper; this muscle, however, deserves its human name so little in the Macaque, that it is only equal in weight to the *glutæus minimus*, which is 165 grs.

The whole complex muscle is inserted below and behind the great trochanter, and into the whole of the great fascia covering the thigh on the outer side.†

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* This and the following figures were drawn from nature by my son.

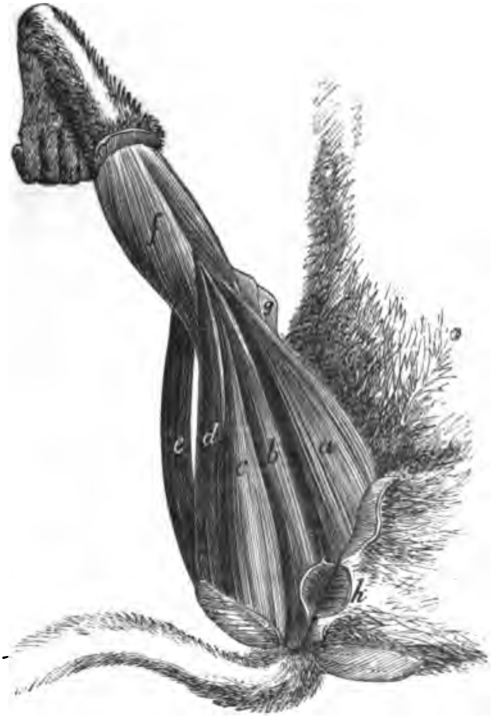
† The fibres of this curiously shaped muscle are not parallel, but converge through an angle of 16°, to a point 14½ inches from the crest of the ilium; and their resultant

2. *M. glutæus medius*, ... 1·95 oz.
3. *M. glutæus minimus*, ... 0·37 oz.
4. *M. biceps femoris* (Fig. 21, *a*; Fig. 22, *b*; Fig. 23, *e*), . 1·10 oz.
   Inserted into the back of the lower third of the femur, and by fascia down the upper third of the leg; the resultant plane of all its fibres falls below the knee joint.
5. *M. semitendinosus* (Fig. 23, *b*), ... 0·61 oz.
   Takes origin from the *tuber ischii*, and is inserted by a flat tendon into the upper point of trisection of the tibia.
6. *M. semimembranosus* (Fig. 23, *d*), 0·67 oz. Origin; the posterior line of ischium. Insertion; into the top of the tibia by a round tendon.
7. *M. gracilis* (Fig. 23, *a*), . . 0·55 oz. Origin; from the *symphysis pubis*. Insertion; beside the *semimembranosus*, and inside the *sartorius*, into the upper fourth of the tibia.
8. *M. sartorius*, (Fig. 22, *e*), . . 0·32 oz.
9. *M. adductor longus* (Fig. 23, *c*), 0·90 oz. Origin; from the spring of the arch of the pubis. Insertion; into the back of the inner condyle, and one inch up the femur.
10. *M. adductor magnus*, . . 3·20 oz.

Fig. 23.

COMBINATION OF FLEXORS OF THE KNEE JOINT IN THE MACACUS NEMESTRINUS

(viewed from behind, in the lithotomy position),



a, *Gracilis.*
b, *Semitendinosus.*
c, *Adductor longus.*
d, *Semimembranosus.*
e, *Biceps femoris.*
f, *Gastrocnemius.*
g, Dislocated patella.
h, Bulb of urethra.

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divides the base line joining the crest of the ilium with the second caudal vertebra in the proportion of 31 to 36.

Origin; fleshy, from the symphysis and arch of the pubis.
Insertion; into the entire length of the back of the femur.

11. *M. adductor brevis*, ... 0·37 oz.
Origin; from the top of the symphysis pubis.
Insertion; into the second upper fourth of the back of the femur.

12. *M. pectinæus*, 0·22 oz.
Origin; from the pectinæal line.
Insertion; into the upper fourth of the back of the femur.

13. *M. quadriceps extensor femoris*, 2·32 oz.
1. *Rectus*, 0·80 oz.
2. *Vastus externus*, 0·82 oz.
3. *Vastus internus*, 0·40 oz.
4. *Cruræus*, 0·30 oz.

14. *M. psoadiliacus*, 1·87 oz.

15. *M. psoas parvus*, 0·27 oz.

16. *M. iliocapsularis*, 5 grs.
Although small, this muscle was very distinct.

17. *M. quadratus femoris*, 0·46 oz.

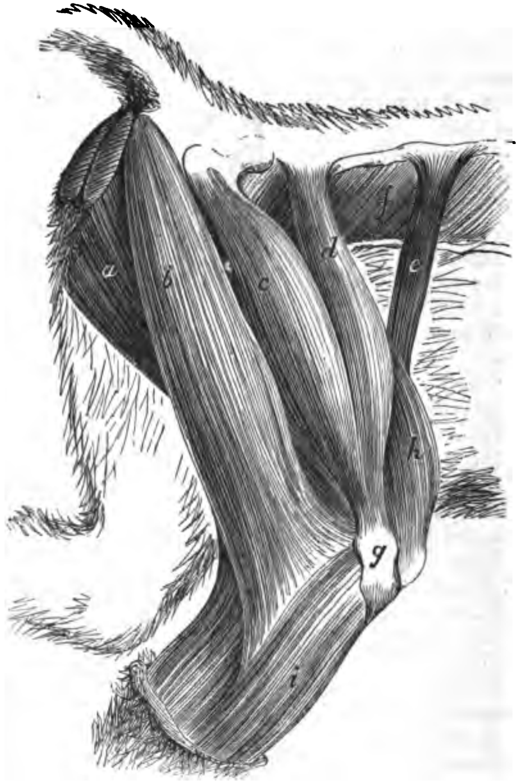
18. *M. obturator externus*, 0·53 oz.

19. *MM. obturator internus et gemelli*, 0·75 oz.

20. *M. poplitæus*, 0·06 oz.

Fig. 22.

DEEP MUSCLES OF RIGHT LEG OF MACACUS NEMESTRINUS.



a, *Semitendinosus* and *adductor longus*.
b, *Biceps femoris*.
c, *Vastus externus*.
d, *Rectus femoris*.
e, *Sartorius*.
f, *Psoadiliacus*.
g, Dislocated patella.
h, *Vastus internus*.
i, Outer portion of *gastrocnemius*.

An interesting observation may be made upon the muscles that act upon the knee joint: that they do not all act in the plane of motion of the joint itself, but at the same time their actions are so balanced, that their total resultant is, in all probability, accurately in that plane; this indeed is a result to be expected in a hinge joint like the knee, for otherwise there would be a constant wrench produced on the joint, by the unbalanced rotation outwards or inwards.

Of the muscles that flex the knee joint, the ***biceps***, ***semimembranosus***, and ***sartorius*** were found to act in the plane of the joint, while the ***semitendinosus*** abducted at an angle of 5° 40′, and the ***gracilis*** adducted at an angle of 8°.

A little consideration will serve to show, provided my postulates be admitted, that the ***semitendinosus*** wrenches the joint by a rotation *inwards*, represented by its weight multiplied by the sine of the angle its plane makes with the plane of motion of the knee joint; and that the *gracilis* wrenches the joint by a rotation *outwards*, represented by a similar quantity.

Hence we find

Wrenching moment *inwards* of ***semitendinosus*** = 0·61 × sin 5° 40′ = 0·06 oz.
" *outwards* of ***gracilis*** = 0·55 × sin 8° = 0·07 oz.

These two wrenching moments nearly balance each other, so as to leave little or no strain on the joint; and it is probable that the slight difference between them is compensated by the action of the ***poplitæus***, which aids the ***semitendinosus*** to some extent.

The flexors of the leg are well shown in Fig. 23, which represents them all in their natural positions, with the exception of the ***biceps***, which has been drawn out of its place, in order to show better the position of the remaining muscles.

21.	***M. gastrocnemius***,	0·89 oz.
22.	***M. solæus***,	0·63 oz.
23.	***M. plantaris***,	0·18 oz.
24.	***M. flexor digitorum longus***,	0·36 oz.
25.	***M. tibialis posticus***,	0·30 oz.
26.	***M. flexor hallucis longus***,	0·66 oz.
27.	***M. accessorius***,	0·05 oz.

The tendon of the ***flexor hallucis*** divides, in the centre of the sole, into tendons distributed to the 3rd and 4th toes, and another tendon which constitutes half the tendon of the hallux.

The tendon of the ***flexor digitorum*** divides at the same point into tendons distributed to the 2nd and 5th toes, and another tendon which constitutes the remaining half of the tendon of the hallux.

The *M. accessorius* tendon meets all the foregoing at the point of subdivision; but its largest branch is continued directly on, into the tendon of the ***flexor hallucis***.

The distribution of the flexor tendons to the toes varies in different genera of Monkeys.

In the ***Cebus***, their distribution is like that of the ***Macacus nemestrinus***, viz., ***flexor hallucis*** to 3rd, 4th, and half the hallux;

and *flexor digitorum* to the 2nd, 5th, and half the hallux; and they all anastomose together in the sole of the foot, where they are joined by the *accessorius.*

In the *Cercopithecus fuliginosus* (Cuvier), or Sooty Mangaby, with white eyelid, the *flexor digitorum* supplies the tendons of the 2nd and 5th toes, and one-third of the tendon of the hallux; the *flexor hallucis* supplies the tendons of the 3rd and 4th toes, and two-thirds of the tendon of the hallux; and there is no *accessorius* muscle.

In the *Hapale*, the *flexor hallucis* supplies the 3rd and 4th toes only, so that its human name becomes inappropriate; and the *flexor digitorum* supplies the 2nd and 5th toes, with a small slip to the hallux.

In the *Lagothrix* the *accessorius* muscle is wanting, and the *flexor hallucis* is distributed to the 2nd, 3rd, and 4th toes, and partly to the hallux, while the *flexor digitorum* supplies the 4th and 5th toes, and partly the hallux.

In the *Chimpanzee*, the *flexor hallucis* supplies the whole tendon of the hallux (to which one-third of its force is sent), one-third of the tendon of the 2nd toe, two-thirds of that of the 3rd toe, and the whole of the 4th toe; while the *flexor digitorum* supplies two-thirds of the tendon of the 2nd toe, one-third of that of the 3rd toe, and the whole of the 5th. There is no *accessorius.*

In *Man*, the *flexor hallucis* supplies the whole tendon of the hallux, and half that of the 2nd toe (two-thirds of its force going to the hallux, and one-third to the 2nd toe); and the *flexor digitorum* supplies the remaining half of the tendon of the 2nd toe, and the whole tendons of the 3rd, 4th, and 5th toes; and the *accessorius* combines the two tendons together in the sole of the foot, pulling on both.

The different mechanical uses of the foot, indicated by these various arrangements, would form a most interesting study for an anatomist, who might have the opportunity of observing the animals during life, with their varied habits of grasping, climbing, and walking.

28. *M. peronæus longus*,	0·32 oz.
29. *M. peronæus brevis*,	0·24 oz.
30. *M. tibialis anticus*,	0·79 oz.

This muscle is composed of two distinct portions, inserted respectively into the cuneiform bone and into the metatarsal of the hallux.

Cuneiform portion,	0·56 oz.
Metatarsal portion,	0·23 oz.

31. *M. extensor digitorum communis*,	0·27 oz.
32. *M. extensor proprius hallucis*,	0·12 oz.
33. *M. extensor digitorum brevis*,	0·10 oz.
34. *MM. abductor et opponens hallucis*,	0·08 oz.

35. *M. flexor digitorum brevis* (*perforatus*),	0·08 oz.

This muscle is divided into two parts:—

1. *Flexor indicis perforatus*, having the human origin.
2. *Flexor digitorum*, having an origin from the *flexor digitorum longus* tendon, to which it is an accessory muscle.

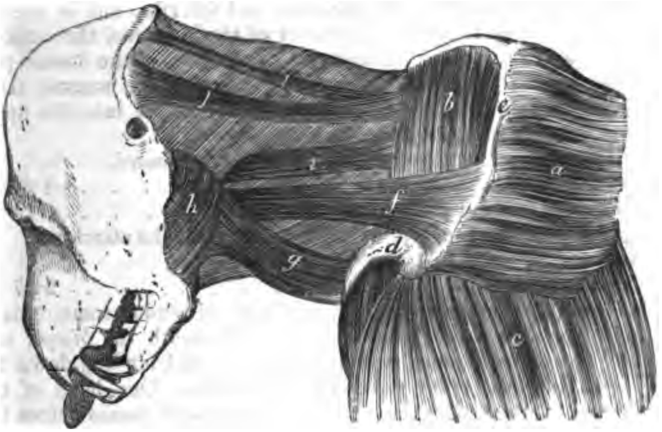
36. *M. abductor minimi digiti*,	0·04 oz.
37. *M. flexer hallucis brevis*,	0·07 oz.
38. *M. adductor hallucis*,	0·22 oz.

Muscles of Arm and Hand.

1. *M. trapezius*,	1·50 oz.
2. *M. omo-atlanticus* (Fig. 24, *f*),	0·31 oz.

Fig. 24.

MACACUS NEMESTRINUS.



a, *Trapezius*, reflected.
b, *Supraspinatus*.
c, *Deltoideus*.
d, Clavicle.
e, Spine of scapula.
f, *Omo-atlanticus*.
g, *Sternomastoideus*.
h, *Massetericus*.
i, Accessory atlantic slip of *serratus magnus*.
jj, Accessory occipital slips of *rhomboideus*.

Origin; from the transverse process of the atlas.

Insertion; into the anterior third of spine of scapula.

The insertion of the omo-atlantic muscle in the *Macacus nemestrinus* forms an exception to its usual insertion in the smaller Macaques, in which it is attached to the third of both the clavicle and spine of the scapula nearest the shoulder joint. Its insertion in the *M. nemestrinus* is like that of the Cercopitheci. In *Cynocephalus porcarius* and *C. maimon* it is inserted into the outer third of the spine of the scapula only. This muscle is wanting in the Cebus.

3. *M. rhomboideus* (*vide* Fig. 24, *jj*), ... 0·70 oz.

Origin; from the spinous processes of the upper half of the dorsal vertebræ, all the cervical, with *two* accessory slips from the occipital ridge, shown at *jj*, Fig. 24.

Insertion; into the vertebral edge of the scapula.

One or more of these accessory slips of the rhomboid muscle are present in most of the Macaques and Cercopitheci, and Cynocephali; they are to be regarded as portions of the rhomboid, with origin extended to the head, and are connected with motions of the head and shruggings of the shoulder, essentially ape-like, and not human. The accessory slip of the Rhomboid muscle is wanting in the Cebus.

4. *M. sternomastoideus* (Fig. 24, *g*), ... 0·61 oz.

5. *M. pectoralis major*, ... 1·62 oz.

6. *M. pectoralis minor*, ... 0·83 oz.

This muscle is divisible into two portions, of which the first takes origin from the 2nd, 3rd, 4th, 5th, and 6th ribs, and is inserted into the top of the great tuberosity of the humerus, the coracoid process, and capsular ligament; this portion of the lesser pectoral weighs 0·57 oz.; the second portion of the muscle arises from the 6th, 7th, and 8th ribs, and is inserted into the upper and anterior margin of the bicipital groove.

The first portion may be regarded as a *levator humeri*.

7. *M. deltoideus*, ... 1·37 oz.

8. *M. subclavius* (second pectoral of birds?) . . . . . . 0·13 oz.

Origin; from the junction of the first rib with the sternum.

Insertion; into the inferior edge of the clavicle.

9. *M. latissimus dorsi*, ... 2·57 oz.

This muscle is inserted, by means of a broad tendon common to it with the *teres major*, into the humerus beneath the *biceps*, and also by a tendinous band passing over and binding down the *biceps*, into the outer side of the humerus. One head of the *triceps* is attached to the *latissimus dorsi*, as it passes across the axilla.

10. *M. serratus magnus* (*vide* Fig. 24, *i*), ... 1·66 oz.

In this muscle I have included the *levator anguli scapulæ*, which cannot be separated from it as a distinct muscle, and also the distinct slip figured at *i* (Fig. 24), which takes its origin from the posterior tubercle of the transverse process of the atlas.

11. *M. supraspinatus* (Fig. 24, *b*), ... 0·85 oz.

12. *M. infraspinatus*, ... 1·07 oz.

13. *M. triceps*, ... 3·33 oz.

This muscle has four heads—

1. From the *latissimus dorsi*.
2. From the anterior half of the lower edge of the scapula.
3, 4. Double origin, fleshy, from the back of the humerus, as in Man.

14. *M. teres major,* . . . . 0·80 oz.

    Origin; from the posterior inferior angle of the scapula.

    Insertion; with the *latissimus dorsi,* by means of a broad tendon, of which the *teres* forms two-thirds, and the *latissimus* one-third.

15. *M. teres minor,* . . . . 0·15 oz.
16. *M. subscapularis,* . . . . 1·45 oz.
17. *M. biceps humeri,* . . . . 1·57 oz.
18. *M. coracobrachialis,* . . . . 0·12 oz.

    This muscle is intimately blended with the coracoid head of the *biceps.*

19. *M. brachialis anticus,* . . . . 0·47 oz.
20. *M. pronator radii teres,* . . . . 0·32 oz.
21. *M. flexor carpi radialis,* . . . . 0·37 oz.
22. *M. palmaris longus,* . . . . 0·18 oz.
23. *M. flexor sublimis digitorum,* . . . . 0·77 oz.
24. *M. flexor carpi ulnaris,* . . . . 0·73 oz.
25. *M. supinator radii longus,* . . . . 0·77 oz.
26. *M. extensor carpi radialis longior,* . . . . 0·33 oz.
27. *M. extensor carpi radialis brevior,* . . . . 0·32 oz.
28. *M. extensor digitorum communis,* . . . . 0·34 oz.
29. *M. auricularis,* . . . . 0·08 oz.

    This little muscle sends a tendon to the 4th as well as to the 5th finger.

30. *M. extensor carpi ulnaris,* . . . . 0·28 oz.
31. *M. flexor digitorum profundis,* } *M. flexor pollicis longus,* } . . . . 1·95 oz.

    There is no distinct *flexor pollicis longus;* but a tendon branches off to the thumb, from the central portion of the tendon of the *flexor digitorum profundus,* that supplies the 3rd and 4th fingers. I found by trial that the weights of equal lengths of the thumb tendon and common tendon to the other four fingers were as 116 to 243; showing that one-third of the whole force of the muscle is expended on the thumb, and the remaining two-thirds on the other fingers—for it is easy to see that the forces acting along the subdivided tendons must be exactly proportional to their strengths as measured by the weights of equal lengths.

    The peculiarities of the human *flexor pollicis longus* have always been insisted upon by anatomists as essentially characteristic of Man, as distinguished from the Quadrumans; but exceptions of the most startling kind are occasionally met with. While I was engaged in the dissection of the *Macacus nemestrinus,* I called the attention of Mr. Finney, Medical Scholar of Trinity College, to the arrangement of the tendons of the deep flexor, who then mentioned to me the case of a male subject dissected by him in November, 1864. On referring to his note book, I was able to extract the following observation:—

"Abnormal *flexor pollicis longus.*—The fleshy origin of this muscle from the bone of the forearm was entirely wanting, and the tendon of the *flexor pollicis longus* was attached opposite to the base of the 3rd metacarpal bone, to the tendons of the *flexor digitorum profundus,* on their superficial surface."

This remarkable example shows that Man may sometimes possess the arrangement of tendons of thumb and fingers characteristic of the Macaque; but whether such a case should be regarded as a Macaque passing upwards into a Man, or a Man passing downwards into a Macaque, or as a congenital freak of nature, I cannot undertake to say.

In the *Cercopithecus fuliginosus* (Cuvier), the tendon of the *flexor pollicis longus* springs, as in the Macaque, from the central portion of the tendon of the *flexor profundus* that supplies the middle and ring fingers.

In the Cebus and Lagothrix, a more degraded type of thumb is found; for the *flexor pollicis longus* is represented by a tendon to the thumb, not proceeding from the central portion of the tendon of the *flexor profundus,* but by a tendon which is merely one of the five tendons into which the *flexor profundus* is divided in the lower animals.

It is remarkable, however, that among the Quadrumans the most degraded type of thumb is to be found in the so-called Anthropoid Chimpanzee, for an opportunity of dissecting which, as well as the Negro Monkey, I am indebted to the kindness of Mr. Thomas J. Moore, Curator of the Derby Museum, of Liverpool. In the Chimpanzee, the tendon of the *flexor pollicis longus* is formed by the union of two small thread-like tendons; of which one, of silky texture, is derived from the muscle of the *flexor sublimis* (*perforatus*), of the index finger; and the other, equally slender, but wanting the silky lustre, proceeds from the tendon of the *flexor sublimis* of the little finger.*

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* The following remarks on this curious subject, by Professor Gratiolet, will be read with interest by anatomists:—

"The anatomical examination of this Chimpanzee (*Troglodytes Aubryi*) reveals profound and really typical differences between man and the most elevated apes. In the latter the thumb is bent by an oblique division of the common tendon of the muscle which bends the other fingers; it is, therefore, influenced by the common movements of flexion, and therefore is not free. This type is realized in the Gorilla and Chimpanzee; but the small tendon which moves the thumb is in these reduced to a tendinous thread, which exerts no action, for its origin is lost in the synovial folds of the tendons which bend the other fingers, and it abuts on no muscle; the thumb, therefore, in these apes is wonderfully enfeebled. In none of them is there a trace of the large independent muscle which gives movement to the human thumb. Far from becoming more strongly deve-

32.	*M. pronator quadratus*,		0·10 oz.
33.	*M. supinator radii brevis*,		0·22 oz.
34.	*M. extensor ossis metacarpi pollicis*,		0·25 oz.
35.	*M. extensor primi internodii pollicis*, *M. extensor secundi internodii pollicis*,	united,	0·05 oz.
36.	*M. indicator*,		0·05 oz.
	This muscle sends a tendon to the middle finger, as well as to the index.		
37.	*M. abductor pollicis*,		0·05 oz.
38.	*M. opponens pollicis*,		0·03 oz.
39.	*M. flexor pollicis brevis*,		0·11 oz.
40.	*M. adductor pollicis*,		0·03 oz.

XIX.—Notes on Animal Mechanics. By the Rev. Samuel Haughton, M. D., Fellow of Trinity College, Dublin.

[Read before the Royal Irish Academy, June 26, 1865.]

No. VIII.—*Further Comparison of the Hip Joint and Knee Joint Muscles in the Circopithecus, Cynocephalus, and Macacus.*

Since publishing in Notes I. and II. my earlier observations on the muscular mechanism of the hip joint in Man and some of the lesser Monkeys, I have made further observations on this subject, a summary of which seems to me worthy of being laid before the Academy.

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loped, the member so characteristic of the human hand seems in the most elevated apes (the Orangs) to incline to a complete annihilation. These apes, therefore, have nothing in the organization of their hand which indicates a passage into the human form; and I insist in my memoir on the profound differences revealed by the study of the movements in hands formed to accomplish objects of a totally distinct order. A close examination of the muscles of the arm and shoulder in the pretended anthropomorphous apes confirms these results. Besides, it is especially in the ape in appearance the most like man—the Indian Orang—that the hand and foot present the most striking degradations. This paradox—this default in the parallelism in man and the large apes in the developement of correlative organs, such as the brain and the hand—shows absolutely that other harmonies and other destinies are here in question.

"The facts upon which I insist permit me to affirm, with a conviction founded on a personal and attentive study of all at present known, that anatomy gives no grounds for the idea, so violently defended now-a-days, of a close relationship between man and ape. One may invoke in vain some ancient skulls, evident monstrosities, found by chance, such as that of Neanderthal—and here and there similar forms may now be found; they belong to idiots. One of these was discovered a few years ago by Dr. Binder, who, at the request of M. Macé, presented it to me. It is now in the collection belonging to the Museum. It will henceforth be counted among the elements of the great discussion on the nature of man which now agitates philosophers and troubles consciences; out of which discussion, some day, the divine majesty of man shall arise consecrated by combat, and ever henceforth be inviolable and triumphant."

1. *Cercopithecus mona ?* (male).

From the dissection of a specimen of a male *Cercopithecus mona* I obtained the following results:—

Muscle.	Actual Weight. Grs.	Percentage.	
1. Psoadiliacus,	385	9·5	
2. Adductores,	836	20·7	
3. Glutæus maximus,	209	5·1	
4. Glutæus medius,	407	10·1	
5. Glutæus minimus,	44	1·1	
			46·5
1. Biceps femoris,	561	13·9	
2. Semimembranosus, 3. Semitendinosus,	330	8·1	
4. Gracilis, 5. Sartorius,	198	4·9	
6. Quadriceps extensor femoris,	1080	26·6	
			53·5
Totals,	4050 grs.	100·0	100·0

	Grs.
Weight of Monkey,	51,860
„ heart,	286
„ liver,	1650
„ brain,	946

	Percentage.
Proper muscles of hip joint,	46·5
Flexors of knee,	26·9
Extensors of knee,	26·6
	100·0

On projecting the planes of motion of the hip joint muscles on the plane of the rim of the acetabulum, I obtained the following results:—measuring the azimuths of the moments from the plane of motion of the knee joint, which is the natural zero plane for the hip joint—

Muscle.	Azimuth.	Moment.
1. Psoadiliacus,	20°	9·5
2. Adductores,	139	20·7
3. Glutæus maximus,	326	5·1
4. „ medius,	341	10·1
5. „ minimus,	351	1·1

If we refer these moments to the plane of motion of the knee joint, which is the plane of Flexion and Extension of the thigh upon the body, and to the plane of Adduction and Abduction, perpendicular to the former plane, we can readily construct the following Table of Component Moments:—

Component Moments of Hip Joint Muscles of Cercopithecus mona.

Muscle.	Flexion.	Extension.	Adduction.	Abduction.
1. Psoadiliacus,	8·93	..	3·25	..
2. Adductores,	..	15·62	13·58	..
3. Glutæus maximus,	4·23	..	..	2·85
4. „ medius,	9·55	..	..	3·29
5. „ minimus,	1·08	..	..	0·17
Totals,	23·79	15·62	16·83	6·31

Subtracting the moments acting in opposite directions, we find—

	Percentage.
Total flexion,	8·17
Total adduction,	10·52

2. *Cercopithecus callitrichus?* (male).

From a fine specimen of this Monkey I obtained the following results:—

Muscle.	Actual Weight. Grs.	Percentage.	
1. Psoadiliacus,	360	8·0	
2. Pectinæus,	88	1·9	
3. Obturator externus,	77	1·7	
4. Adductores,	710	15·4	
5. Quadratus femoris,	66	1·4	
6. Obturator internus,	100	2·2	
7. Glutæus maximus,	192	4·2	
8. „ medius,	490	10·6	
9. „ minimus,	60	1·3	
			46·7
1. Biceps femoris,	649	14·1	
2. Semimembranosus,	297	6·4	
3. Semitendinosus,	176	3·8	
4. Gracilis,	198	4·3	
5. Sartorius,	33	0·7	
6. Quadriceps extensor femoris,	1111	24·0	
			53·3
Totals,	4607 grs.		100·0

	Percentage.
1. Proper muscles of hip joint,	46·7
2. Flexors of knee,	29·3
3. Extensors of knee,	24·0
	100·0

Referring the moments of the hip joint muscles to the plane of the brim of the acetabulum, I found—

Muscle.	Azimuth. Degs.	Moment. Percentage.
1. Psoadiliacus,	20	8·0
2. Pectinæus,	94	1·9
3. Adductores,	137	15·4
4. Obturator externus,	149	1·7
5. Quadratus femoris,	180	1·4
6. Obturatur internus,	230	2·2
7. Glutæus maximus,	326	4·2
8. ,, medius,	341	10·6
9. ,, minimus,	351	1·3
		46·7

If these moments be resolved, as before, along the directions of Flexion and Extension of the knee joint, and of abduction and adduction perpendicular to it, we find—

Muscle.	Flexion.	Extension.	Adduction.	Abduction.
1. Psoadiliacus,	7·52	..	2·73	—
2. Pectinæus,	..	0·13	1·89	—
3. Adductores,	..	11·24	10·50	—
4. Obturator externus,	..	1·46	0·87	—
5. Quadratus femoris,	..	1·40	..	—
6. Obturator internus,	..	1·41	..	1·68
7. Glutæus maximus,	3·48	..	..	2·35
8. ,, medius,	10·02	..	..	3·45
9. ,, minimus,	1·28	..	..	0·20
Totals,	22·30	15·64	15·99	7·68

Subtracting opposite moments, we find—

	Percentage.
1. Total flexion,	6·66
2. Total adduction,	8·31

3. *Cynocephalus porcarius* (Chacma).

From a specimen of this Cynocephalus, I obtained the following results and measurements:—

Muscle.	Actual Weight. Ozs. Av.	Percentage.	
1. Psoadiliacus,	0·35	3·1	
2. Pectinæus et Adductor brevis,	0·17	1·5	
3. Obturator externus,	0·27	2·4	
4. Adductor magnus et longus,	1·40	12·6	
5. Quadratus femoris,	0·14	1·3	
6. Obturator internus,	0·31	2·8	
7. Glutæus maximus,	0·57	5·1	
8. „ medius,	1·27	12·3	
9. „ minimus,	0·22	2·0	
			43·1
1. Biceps femoris,	1·40	12·6	
2. Semimembranosus,	0·95	8·5	
3. Semitendinosus,	0·48	4·2	
4. Gracilis,	0·51	4·5	
5. Sartorius,	0·28	2·6	
6. Rectus femoris,	0·63	5·6	
7. Vastus externus,	1·40	12·6	
8. „ internus,	0·45	4·0	
9. Cruræus,	0·25	2·3	
			56·9
Totals,	11·05 oz.		100·0

Proper muscles of hip joint,	43·1
Flexors of knee,	32·4
Extensors of knee,	24·5
	100·0

Referring the moments, as before, to the plane of the rim of the acetabulum, I found—

Muscle.	Azimuth. Degs.	Moment. Percentage.
1. Psoadiliacus,	28	3·1
2. Pectinæus et adductor brevis,	74	1·5
3. Adductor magnus et longus,	137	12·6
4. Obturator externus,	148	2·4
5. Quadratus femoris,	180	1·3
6. Obturator internus et Gemelli,	226	2·8
7. Glutæus maximus, &c.,	328	5·1
8. „ medius et pyr.,	347	12·3
9. „ minimus,	355	2·0
		43·1

Resolving these moments, as before, we obtain—

Muscle.	Flexion.	Extension.	Adduction.	Abduction.
1. Psoadiliacus, ...	2·74	..	1·45	..
2. Pectinæus et Ad. brevis,	0·41	..	1·44	..
3. Obturator externus, ..	..	2·03	1·27	..
4. Add. mag. et long., ..	..	9·21	8·59	..
5. Quadratus femoris, ..	..	1 30	..	..
6. Obt. int. et Gemell., ..	..	1·94	..	2·01
7. Glut. max., &c., ...	4·33	..	..	2·70
8. „ med. et pyriform.,	12·23	..	..	2·76
9. „ minimus,.....	1·99	..	..	0·17
Totals, ...	21·70	14·48	12·75	7·64

Subtracting opposite moments, we find—

	Percentage.
Total flexion, ...	7·22
Total adduction, ...	5·11

4. *Macacus nemestrinus.*

The following Tables are deduced from Note VII., on the Muscular Anatomy of the *Macacus nemestrinus* :—

Muscle.	Actual Weight. Ozs. Av.	Percentage.	
1. Psoadiliacus, ...	1·87	10·9	
2. Pectinæus, ...	0·22	1·3	
3. Adductor brevis, ...	0·37	2·1	
4. „ magnus, ...	3·20	18·8	
5. Obturator externus, ...	0·53	3·1	
6. Adductor longus, ...	0·90	5·3	
7. Quadratus femoris, ...	0·46	2·7	
8. Obturator internus, &c., ...	0·75	4·4	
9. Glutæus maximus, &c., ...	0·90	5·2	
10. „ medius, &c., ...	1·95	11·4	
11. „ minimus, &c., ...	0·37	2·1	
		——	67·3
1. Biceps femoris, ...	1·10	6·8	
2. Semimembranosus, ...	0·67	3·9	
3. Semitendinosus, ...	0·61	3·5	
4. Gracilis, ...	0·55	3·2	
5. Sartorius, ...	0·32	1·8	
6. Rectus femoris, ...	0·80	4·7	
7. Vastus externus, ...	0·82	4·8	
8. „ internus, ...	0·40	2·3	
9. Cruræus, ...	0·30	1·7	
	——	——	32·7
Totals, ...	17·09		100·0

	Percentage.
Proper muscles of hip joint, ...	67·3
Flexors of knee, ...	19·2
Extensors of knee, ...	13·5

Referring the moments of the hip joint muscles to the rim of the acetabulum, I found—

Muscle.	Azimuth. Degs.	Moment. Percentage.
1. Psoadiliacus, ...	26	10·9
2. Pectinæus, ...	55	1·3
3. Adductor brevis, ...	86	2·1
4. ,, magnus, ...	132	18·8
5. Obturator externus, ...	132	3·1
6. Adductor longus, ...	157	5·3
7. Quadratus femoris, ...	180	2·7
8. Obturator internus et Gemelli,	223	4·4
9. Glutæus maximus, &c., . .	335	5·2
10. ,, medius, &c., . . .	348	11·4
11. ,, minimus, . . .	356	2·1

Resolving these moments, as before, we obtain—

Muscle.	Flexion.	Extension.	Adduction.	Abduction.
1. Psoadiliacus, ...	9·77	. .	4·78	. .
2. Pectinæus, ...	0·74	. .	1·06	. .
3. Adductor brevis, ...	0·14	. .	2·09	. .
4. ,, magnus, . . .	. .	12·58	13·97	. .
5. Obturator externus, . .	. .	2·07	2·30	. .
6. Adductor longus, . .	. .	4·88	2·07	. .
7. Quadratus femoris, . .	. .	2·70	. .	. .
8. Obturator internus, . .	. .	3·22	. .	3·00
9. Glutæus maximus, . .	4·71	. .	. .	2·76
10. ,, medius, ...	11·15	. .	. .	2·37
11. ,, minimus, ...	2·09	. .	. .	0·14
Totals, ...	28·60	25·45	26·27	8·27

Subtracting the opposite moments, we find—

	Percentage.
Total flexion, ...	3·15
Total adduction, ...	18·00

If we collect together the preceding results into one Table, having first reduced them to percentages of the proper muscles of the hip joint, we shall obtain the following results, which represent the total flexion and adduction, expressed as percentages, compared with each other.

	Total Flexion.	Total Adduction.
1. Cercopithecus mona, ...	17·57	22·62
2. ,, callitrichus, . .	14·26	17·79
3. Cynocephalus porcarius, . .	16·75	11·85
4. Macacus nemestrinus, . . .	4·68	26·74

The relative proportions of the Glutæi muscles, in the smaller monkeys, I have found to be as follows:—

	Gl. max.	Gl. med.	Gl. min.
1. Cercopithecus mona,	31·6	61·6	6·8
2. „ callitrichus,	25·9	66·0	8·1
3. Cynocephalus porcarius,	27·7	61·6	10·7
4. Macacus nemestrinus,	28·0	60·6	11·4
5. Lagothrix Humboldtii,	37·9	54·5	7·6

XX. — On the Meteoric Stone that fell at Dundrum, in the County of Tipperary, on the 12th August, 1865. By the Rev. Samuel Haughton, M. D., Fellow of Trinity College, Dublin.

(Plate III.)

[Read before the Royal Irish Academy, February 26, 1866.]

The Meteoric Stone, that forms the subject of the present Paper, fell near Dundrum, county of Tipperary, under circumstances that were described to me as follows, by the man in whose garden it fell:—

STATEMENT OF EYEWITNESS.

"I, John Johnson, of the parish of Clonoulty, near Cashel, county Tipperary, was walking across my potato garden, at the back of my house, in company with Michael Fahy and William Furlong, on the 12th of August, 1865, at seven P. M., when I heard a clap, like the shot out of a cannon, very quick, and not like thunder; this was followed by a buzzing noise, which continued for about a quarter of an hour, when it came over our heads; and on looking up, we saw an object falling down in a slanting direction. We were frightened at its speed, which was so great that we could scarcely notice it; but after it fell, we proceeded to look for it, and found it at a distance of forty yards, half buried in the ground, where it had struck the top of a potato drill. We were some time in looking for it (a longer time than that during which we had heard the noise). On taking up the stone, we found it warm, milk warm, but not hot enough to be inconvenient. The next day it was given up to Lord Hawarden.

"John Johnson."

It was afterwards presented by Lord Hawarden to the Geological Museum of Trinity College, where it is publicly exhibited.

The stone weighed 4lbs. 14½ oz. It is rudely pyramidal in form; the triangular base being a freshly broken surface, and the faces of the pyramid being covered by the usual black vitrified glaze. It is evidently a portion of a much larger stone; and as it appears from the foregoing statement that its vertical velocity was not great, it is probable that other pieces of the larger mass may yet be found in the neighbourhood of Dundrum.

A singular feature is observable in this stone that I have never yet seen in any other:—the rounded edges of the pyramid are sharply marked by lines on the black crust, as perfect as if made by a ruler. This appearance is strictly confined to the surface, and seems to be a result of some peculiar tension of the fused crust in cooling; for no trace of any continuation of the lines can be found in the interior of the stone.

On examination with the lens, specks of metallic iron and of magnetic pyrites are visible, and also a few minute grains of chrysolith; no other minerals can be detected in the paste, which is of a dull grey, and of loose texture, almost like a porous sandstone; and the whole stone would attract little notice, were it not for its specific gravity, and the metallic particles visible in it. The specific gravity of this Meteoric Stone, as is usually found to be the case, varied in specimens taken from different parts of the mass. The portion analyzed was found to have the following specific gravity:—

	Grs.
Weight in air, ...	299·6
Weight in water, . . .	201·9
Difference, . .	97·7 grs.

from which data the specific gravity is found to be,

$$\text{Specific gravity} = \frac{2996}{977} = 3\cdot066.$$

Other portions of the stone gave a specific gravity of 3·57.

From 100 grs. acted on with iodine,* which dissolved out the alloy of iron and nickel, there were obtained, of peroxide of iron, 27·95 grs., and of protoxide of nickel, 1·20.

The portion insoluble in iodine was now acted on with dilute muriatic acid, and gave the following results:—

	Grs.	
Silica, ...	12·92	
Alumina, ...	0·15	
Peroxide of iron, ...	9·87	present originally as protoxide and protosulphuret of iron.
Carbonate of lime, ...	0·50	
Pyrophosphate of magnesia, . . .	38·00	
Potash and soda chlorides, ...	0·45	
Platino-chloride of potassium, . . .	0·42	
Oxide of manganese (Mn_3O_4), ...	0·05	

On treating another 100 grs. of the stone for sulphur, with muriatic acid, and conducting the sulphuretted hydrogen into ammoniacal solution of sulphate of copper, so as to form a black precipitate of sulphuret of copper, there were found by the usual methods 10·7 grs. of sulphate of barytes.

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* This method of investigation was suggested by Mr. William Early, Assistant in the Laboratory of Trinity College; the process consists in digesting the powdered mineral in iodine with water for twelve hours, and proved to be completely successful, as was shown by comparative trials on different portions of the powdered mineral.

There were left, after the treatment with iodine and dilute muriatic acid, 42·1 grs. of mineral, insoluble in these reagents.

From the solution by iodine, and the determination of sulphur, as sulphate of barytes, we obtain—

	Grs.		Grs.
Peroxide of iron, ...	27·95	. . .	19·57 iron.
Protoxide of nickel, . . .	1·20	. . .	0·94 nickel.
Sulphate of barytes, . . .	10·70	. . .	4·05 protosulphuret of iron.

Hence we obtain, as our primary analysis of the Dundrum Meteoric Stone—

I.—*Primary Analysis of Meteorite* (A.).

1. Metallic iron, ...	19·57
2. Metallic nickel, ...	0·94
3. Magnetic pyrites, ...	4·05
4. Mineral soluble in dilute muriatic acid, . . .	33·34
5. Mineral insoluble, ...	42·10
	100·00

The analysis of the earthy mineral soluble in dilute muriatic acid gives us (considering that 4·05 of FeS is equivalent to 3·68 of Fe_2O_3) the following result.

II. *Soluble Mineral* (A).

	Grs.	Per Cent.	Oxygen.
1. Silica, ...	12·92	38·74	20·112
2. Alumina, ...	0·15	0·45	0·209
3. Protoxide of iron, . . .	5·51	16·55	3·671
4. Protoxide of manganese, . .	0·05	0·15	0·033
5. Lime, ...	0·28	0·84	0·340
6. Magnesia, ...	13·65	40·93	16·358
7. Potash, ...	0·08	0·24	0·039
8. Soda, ...	0·17	0·51	0·130
9. Loss, ...	0·53	1·59	
	33·34	100·00	40·892

Adding together the oxygen of the protoxides, we find—

$$\begin{array}{l} RO = 20{\cdot}571 \\ \left.\begin{array}{l} SiO_3 = 20{\cdot}112 \\ Al_2O_3 = 0{\cdot}209 \end{array}\right\} = 20{\cdot}321 \end{array}$$

This result identifies the soluble mineral with Chrysolith (or Olivine), unless it be supposed to be a mixture of several minerals. Neglecting all the lesser constituents, we have

$$\begin{array}{lll} & & \text{Oxygen.} \\ SiO_3, \ldots & 20{\cdot}112 & \\ FeO, \ldots & 3{\cdot}671 & \rbrace\, 20{\cdot}039 \\ MgO, \ldots & 16{\cdot}358 & \end{array}$$

which gives very well the formula of Chrysolith,

$$3RO, SiO_3.$$

The preceding analysis of the soluble portion of the Meteorite was checked by the following proceeding:—The 100 grs., from which the sulphur was determined, having been acted on by the muriatic acid, the acid solution was evaporated to dryness, and filtered; and the portion left on the filter was boiled with solution of carbonate of soda, so as to redissolve the silica soluble in muriatic acid. There were left 42·44 grs. of insoluble mineral, while the soluble portion gave

	Grs.	
Silica,	12·36	
Peroxide of iron,	38·60	Present originally as iron, protoxide of iron, and protosulphuret of iron.
Oxide of nickel,	1·44	
Carbonate of lime,	0·40	
Pyrophosphate of magnesia,	32·62	
Potash and soda chlorides,	0·40	

Assuming the iron (metallic) as 19·57, and the protosulphuret of iron as 4·05, we find

Equivalent of 19·57 Fe,	27·94	Fe_2O_3
„ 4·05 FeS,	3·68	„ „
	31·62	

Subtracting this result from the total peroxide of iron, and converting the oxide of nickel into nickel, we obtain

I. *Primary Analysis of Meteorite* (B).

1. Metallic iron,	19·57
2. Metallic nickel,	1·13
3. Magnetic pyrites,	4·05
4. Mineral soluble,	32·81
5. Mineral insoluble,	42·44
	100·00

II. *Soluble Mineral* (B).

	Grs.		Oxygen.	
1. Silica,	12·36	38·86	20·175	
2. Protoxide of iron,	6·28	19·74	4·379	= 19·465
3. Lime,	0·23	0·72	0·204	
4. Magnesia,	11·72	36·85	14·727	
5. Potash,	0·07	0·22	0·036	
6. Soda,	0·15	0·47	0·119	
7. Loss,	1·00	3·14		
	31·81 grs.	100·00		

This result completely verifies that already found, and proves the soluble mineral of the Meteorite to be Chrysolith, having the formula

$$3RO, SiO_3,$$

in which RO denotes protoxide of iron and magnesia.

The 42·10 grs. of mineral insoluble in muriatic acid were divided into equal parts, of which one was fluxed with carbonate of soda, and the other with lime and chloride of ammonium, with the following results:—

	Grs.
Silica,	12·45
Alumina,	0·35
Peroxide of iron,	1·64
Oxide of manganese (Mn_3O_4),	0·16
Peroxide of chrome (Cr_2O_3),	0·51
Carbonate of lime,	1·45
Pyrophosphate of magnesia,	12·45
Potash and soda chlorides,	0·80
Platino-chloride of potassium,	0·90

Assuming the chromium to be present as chrome-iron, and making the necessary reductions in the other elements, we find

	Grs.
Original weight,	21·05
Chrome-iron,	0·75
Insoluble mineral,	20·30 grs.

III. *Insoluble Mineral.*

	Grs.		Oxygen.	
Silica,	12·45	61·33	31·842	
Alumina,	0·35	1·72	0·803	
Protoxide of iron,	1·23	6·06	1·344	11·943
Protoxide of manganese,	0·16	0·78	0·174	
Lime,	0·81	3·99	1·133	
Magnesia,	4·47	22·02	8·800	
Soda,	0·28	1·38	0·352	
Potash,	0·17	0·83	0·140	
Loss,	0·38	1·89		
	20·30 grs.	100·00		

It is not possible to form any opinion as to the mineral composition of the insoluble portion of the Meteorite, as it is doubtless composed of more than one unknown mineral substance.

If we collect into one view the preceding results, taking a mean of all, we obtain the following mineralogical composition for the Dundrum Meteorite:—

IV. *Mineralogical Composition of Dundrum Meteorite.*

1. Nickel-iron,	20·60	Iron, Nickel,	19·57 1·03
2. Protosulphuret of iron,	4·05		
3. Chrome-iron,	1·50		
4. Mineral soluble in muriatic acid, probably chrysolith,	33·08		
5. Minerals insoluble in muriatic acid,	40·77		
	100·00		

ON THE SHOWER OF AËROLITHS THAT FELL AT KILLETER, COUNTY OF TYRONE, ON THE 29TH OF APRIL, 1844.

On the 29th of April, 1844, a shower of Meteoric Stones fell, in the sight of several people, at Killeter, near Castlederg, county of Tyrone: they broke into small fragments by the fall, one piece only being found entire; it was (according to the testimony of a resident) "about as large as a joint of a little finger." The stones were hot when found. The account given by three gentlemen, who, however, did not actually see the shower fall, was that they were at a distance of three or four miles, up the hills in the neighbourhood; it was a fine sunny afternoon (three or four o'clock); they heard "music" towards Killeter, which they supposed to proceed from a strolling German band which they knew to be in the neighbourhood; they are under the impression that they heard the music several times in the course of the evening; they remember also to have noticed clouds in the direction of Killeter. On reaching Killeter, the same evening, they were told of the wonderful shower of stones which had spread over several fields. I received the fragments of these stones from the Rev. Dr. M'Ivor, Ex-Fellow of Trinity College, Dublin, and Rector of Ardstraw: he writes to me that "it is now very difficult to get either a specimen of a stone, or any very distinct intelligence of them: even the very rumour of them has nearly died out, and you might ask intelligent middle-aged men about the neighbourhood who had never heard them mentioned." He adds that the people of that locality are very "uncurious," and that if there were a veritable burning bush thereabouts, few would "turn aside to see."

The largest specimen given to me by Dr. M'Ivor weighed 22·23 grs. in air, and 16·32 grs. in water, showing that its specific gravity is 3·761. Both it and the smaller fragments presented the usual black crust and internal greyish-white crystalline structure and appearance, with specks of metallic lustre, occasioned by the iron and nickel alloy that was present. I analyzed it in the usual manner; but, owing to an accident, I was unable to determine the composition of the earthy portion soluble in muriatic acid.

The following is the mineralogical composition of these Aëroliths:—

1. Hornblendic mineral (insoluble in acid),	34·18
2. Earthy Mineral (soluble in acid),	30·42
3. Iron,	25·14
4. Nickel,	1·42
5. Sesquioxide of chrome,	2·70
6. Cobalt,	trace
7. Magnetic pyrites,	6·14
	100·00

The earthy portion, insoluble in muriatic acid, had the following composition:—

		Atoms.	
Silica,	55·01	1·22	
Alumina,	5·35	0·10	
Protoxide of iron,	12·18	0·34	1·66
Lime,	3·41	0·12	
Magnesia,	24·03	1·20	
	99·98		

Omitting the alumina, the preceding analysis gives the rational formula of the hornblende family,

$$4\,RO,\ 3\,SiO^3,$$

and, taken as a whole, it agrees with the analysis of many hornblendes. The variety of hornblende with which it has the closest relation is anthophyllite.

According to Mr. Gregg's "Catalogue of Meteoric Stones and Irons," three other falls of Aëroliths are recorded as having occurred in Ireland:—

1. A. D. 1779, at Pettiswood, Westmeath; 6 oz.
2. August, 1810, Mooresfort, county of Tipperary; 7¾ lbs. Spec. grav. = 3·670.
3. September 10, 1813, Adare, county of Limerick; 17 lbs. + 65 lbs + 24 lbs.; moving E. to W. Spec. grav. = 3·64.
4. April 29, 1844, Killeter, county of Tyrone; fragments of one stone. Spec. grav. = 3·761.

Of the Meteorite that fell at Mooresfort, county of Tipperary, in 1810, the only analysis on record is one published by the late Professor Higgins, in the forty-seventh volume of the "Proceedings of the Royal Dublin Society," in whose Museum the greater part of this stone, and a cast of the entire, are carefully preserved.

Professor Higgins considered 35 per cent. of the stone to consist of metallic particles separable by the magnet. This would include the magnetic pyrites, iron, nickel, and chrome. In the Tyrone Meteorite examined by me, the iron, nickel, chrome oxide, and magnetic pyrites amounted to 35·40 per cent., which is very nearly the same proportion.

Dr. Apjohn has published a detailed account of his analysis of the Adare Meteorite in the eighteenth volume of the "Transactions of the Royal Irish Academy," from which it appears that the following is the mineralogical composition of that Meteorite:—

1. Meteoric iron and nickel,	23·07
2. Magnetic pyrites,	4·38
3. Chrome iron,	3·34
4. Earthy matrix,	68·47
5. Alkalies and loss,	0·74
	100·00

Its specific gravity varied from 3·621 to 4·230. The composition of the matrix of 200 grs. was found to be—

	Grs.
Silica,	78·19
Magnesia,	43·13
Protoxide of iron,	15·62
	136·94

XXI.—ON SOME INSCRIBED STONES AT KILLEEN CORMAC, NEAR DUNLAVIN. By the Rev. JOHN F. SHEARMAN.

[Read before the Royal Irish Academy, May 22, 1865.]

AMONG the many places and objects of antiquarian interest in the neighbourhood of Dunlavin, is the ancient cemetery of Killeen Cormac, lying to the south-west of Dunlavin, and distant from it about three miles. It is situated on the lands of Colbinstown, in a detached portion of the parish of Davidstown, in the barony of E. Narragh and Reban, county of Kildare. This interesting spot lies in a valley of picturesque character, traversed by the River Griese, here separating Wicklow from Kildare, and the diocese of Leighlin from that of Glendalough. This valley is diversified by insulated mounds or eskars, which, as they still retain their Irish names, and being connected with the history of the locality, a description of them may not be deemed foreign to the subject of this paper.

On the left bank of the Griese, in the parish of Ballynure, is a long eskar, called Bullock Hill, the legend of which will hereafter appear. On the right bank is another elevation, called Cnoc Bunnion,* by way of opposition to Bullock Hill. Beyond this is another eskar, the highest of the group, called Rathown Beck, having on its summit a well-preserved moat, of large dimensions. A small stream, called the Srughan, *i. e.* little river, flows under it, and joins the Griese in the vicinity. Another mound lies between this and Cnoc Bunnion, which is the site of the old cemetery of Killeen Cormac, the subject of this paper. This eskar is of oval form, its major axis lying nearly east by west. It is occupied by the remains of three concentric enclosures, dividing the surface of the slopes into as many steps or terraces, the highest of which, on the western end, is fashioned into a moat or rath, in which is a square depression, excepting which there are no direct indications of the site of the church.

A great quantity of large stones lie about, and plainly indicate that a building of primitive design, and of Cyclopean structure, must have once occupied the summit of this mound. These terraces are now in a very ruinous state; but sufficient indications remain to convey a fair idea of their original construction. On the east side the outline of the middle terrace is well preserved by the large flat stones, set on their edges, against the bank; and on the western end, under the moat, the same construction occurs, but in a more dilapidated state, the stones having fallen from their upright position through the lateral pressure of the banks which they sustained. These flags are of greenstone, and quarries producing such exist on the Hill of Uske, in the vicinity.

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* Bunian is female; bo, gen. boin, a cow.

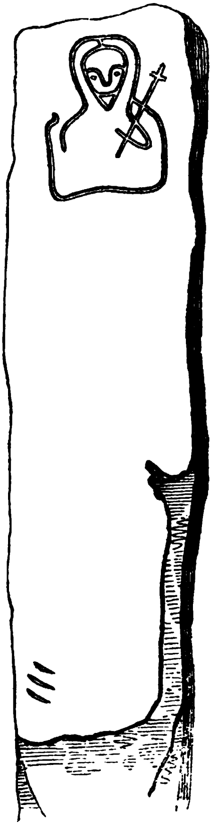
Pillar stones, fragments of what may have been rude crosses, of coarse-grained granite, lying scattered about, with the rocks which formerly supported the terraces, give to Killeen Cormac an appearance of antiquity which it is extremely difficult to describe.

About the year 1830, a wall was raised round this cemetery, and built on the line of the first terrace, and with some of its *debris*, and trees were planted inside; so that it may be hoped the existing remains will be preserved from wanton injury, and will be no further disturbed. The modern entrance faces the highroad, but at a considerable distance from it. It is on the north-west side, and probably occupies its original position.

On entering, the first objects that are to be seen are two prostrate pillar stones—one on the left, the other on the right hand side.

No. 1 is a block of greenstone, partially stratified, measuring in length six feet five inches; the upper surface, at the top, ten inches wide, and at the base eight inches; the side, at the top, eleven inches deep, by fourteen inches at the base. This pillar, at its top surface, bears a faintly incised bust, which appears to represent the Redeemer, in a style of art so very archaic that any example of similar workmanship is scarcely to be found in these islands. On the same side, but near the middle, and close to the edge or oriss of this stone, three incised strokes or scores exist, as if a commencement had been made for an inscription in the Ogham character. On the side of the stone, under these scores, is a mark of the stratification, across which is cut a single score, looking, as it now stands, like a cross, being probably another attempt at an Ogham inscription.

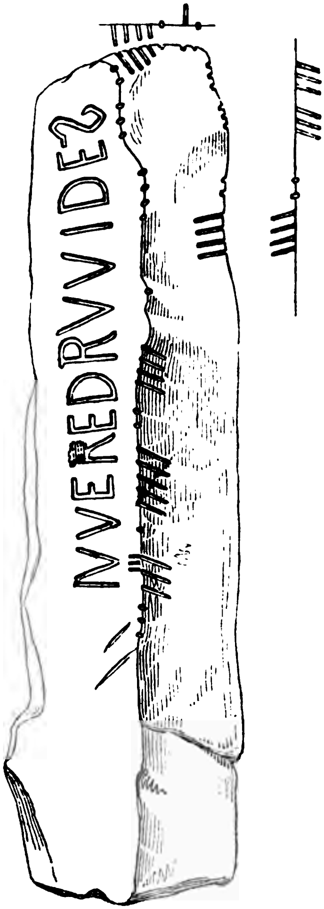
Fig. 1.



The pillar stone to the right (No. 2) is of the same material, but of more irregular outline. It measures in length nearly six feet four inches; the greatest width at the base of the lettered surface is twelve inches, and ten towards the top of the same side; on the Ogham side it measures in depth twelve inches along its entire length. This pillar stone is one still more remarkable than that already described. It appears to be the first, and, as far as is known, the only example in Ireland of a Roman and Ogham inscription coexisting, and probably equivalents of each other, on the same monument.

On his first visit to Killeen Cormac the writer perceived the Ogham scores; but the Roman letters partially escaped his observation, owing to their shallowness; besides, he was unprepared to meet with a monument of such extreme antiquity and rareness in that part of Ireland, which he regarded as fully explored. Being, however, at Killeen Cormac on an October evening, in 1860, which was showery, with intervals of bright sunshine, and then examining these monuments, the depressions of the Roman letters, being filled with water, and glistening under the setting sun, enabled him to read distinctly the words IVVE-REDRVVIDES, and excited a most lively interest in the discovery. Rubbings were then made, and since that time very frequently, and more carefully.

Fig. 2.



This remarkable discovery was communicated to the late Eugene O'Curry, and also to the Rev. James Graves, Hon. Sec. to the Kilkenny Archæological Society, who urged the writer to make it public; which he was not then willing to do, for want of sufficient information regarding the locality and its history. After this he set about collecting the history and legends connected with this cemetery in every quarter likely to afford information. Subsequent inquiries brought to the surface many traditions of much interest, which were all but forgotten; and it is much to be regretted that similar investigations have not been made in other historic localities, as yet unexplored, by persons having the same facilities as the writer; as these traditions, if not soon collected, seem to be doomed to oblivion among the rising generation of our countrymen.

At the time these rubbings were made the writer was not acquainted with the force or phonetic value of the Ogham characters, nor does he now take it on himself to say that the Ogham is an equivalent for the Roman inscription; but in connexion with the word DRVVIDES, it has been suggested that there is a combination of Ogham characters reading the word *SAEI,* which is most probably the Irish equivalent of the DRVVIDES of the Roman or Latin inscription. At the first reading of this inscription, its great novelty gave ample room for speculation.

It struck the writer that he had perhaps alighted on the stone that may have marked the grave of Dubhtach mac ua Lugair, the chief Druid of Leinster, and St. Patrick's first convert at Tara, when opening his mission there before King Laoghaire, when he called to mind Dubhtach's connexion with St. Fiacc of Sleibte (Sletty), which is in a territory adjoining Killeen, which is itself in the very locality of Dubhtach's literary labours; the plain in which Killeen is situated being mentioned in his third poem on Enna Kinsellagh, who is there called "The Hero of Magh Fhine."* In the same poem Mugna (or Moon Columbkile), and Maisden (Mullaghmast), are named, and are in the vicinity of the locality under notice. These coincidences were supposed to give a clue to the identification of the personage commemorated in the Roman inscription on this very ancient monument; and more recently the publication of the Senchus Mor appears to add another link to the chain of evidence, by the fact of Dubhtach mac ua Lugair being there spoken of as Dubhtach doctor of literature, the Irish being Dubtach sai litri.

The River Griese that flows by this ancient cemetery is called, in the poem of Meabth, daughter of Conan, Glaissi Crichi, or the boundary stream. Mr. O'Curry refers this poem to a very remote period, so that we may conclude that this locality was one of importance at an early period of Irish history.†

Returning now to the description of the other pillar stones, and going to the western end of this mound, under the moat on the first terrace, is another pillar stone (No. 4), standing about five feet above the surface; it is nearly square, and presents no feature of interest, except that at its eastern edge there are some scores, perhaps the remains of an Ogham inscription. On the second terrace, above this stone, is an irregular-shaped flag (No. 3). It is of coarse greenstone, very rough and hard, and much weather-worn. An Ogham inscription is carried up the two sides and top. As it has been most carefully examined, the annexed engraving is a faithful copy of the scores now existing on this curious monument.

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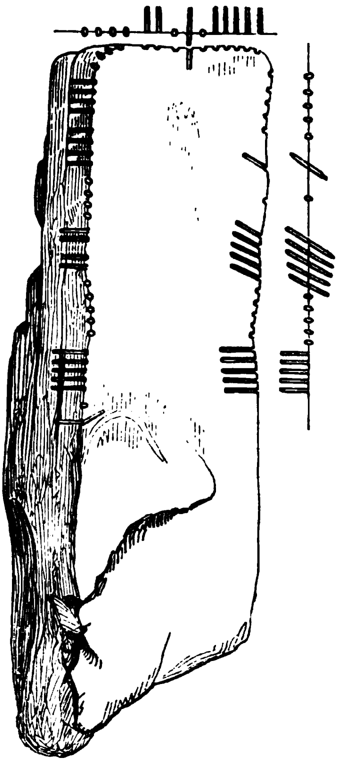
* *Vide* O'Curry's "Lectures," App. III., p. 486, note 45.

† It would appear from an extract from the "Book of Lecain," fol. 95 a, kindly supplied by Mr. William M. Hennessy, that the territory in which Killeen Cormac is situated belonged to a branch of the tribe of Messincorb, called the Ui Cormaic, or Fine Cormaic, whose possessions with those of their correlatives are thus minutely described:—

"Ite randa h. ngabla ⁊ h Cormaic la Laignib .i. na ngebthe h. nGabla Ḟine uili, ⁊ Cuthraigi, ⁊ h. Gabla rairend, ota Ath culchinged co dub athaib Maisten, otha Glais Chrichi i Cluanaib co uado fri laigis, co clandtais, co hAth Leathnocht oc Sleibtib, co teit in Usci fri huib mbairrchi, ⁊ anangebthi .h. Threna ⁊ .h. Chuircc is la .h. Chormaic uili. Is dib Abban mac .h. Cormaic. Is uadib mathair Choluim mic Crimthainn .i. Mincloth ingen Cenandain, mic Ceri, mic Lugdách, mic Labrada. Is dib Cormaic in da Sinell .i. Sinell mac Cenandain, mic Macha, mic Chruaich, mic Duilgi, mic Imchada, mic Brolaig, mic Lugdach, mic Labrada; ocus Sinell sean mác Corcráin, mic Erc, mic Chruáich, mic Duilgi, ⁊ araile."

"These are the divisions of Ui Gabhla and Ui Cormaic in Leinster, viz., where the Ui Gabhla all are found, and Cuthraighi and Ui Gabhla of Rairend (Mullach Reelan); from Ath-Culchinged to the Black Fords of Maisten (Mullachmast); from Glas Crichi in Cluana to Vado toward Laighis (Leix), to Clanties, to Ath-Leathnocht at Sleibhti (Sletty), until it goes into Usci (hill of Usk), towards Ui Bairchi; and wherever are found Ui Threna, and Ui Chuirc, all belongs to Ui Cormaic. Of them is Abban Mac Ui Cormaic. From them was the mother of Colum mac Crimthann, viz. Mincloth, daughter of Cenanan. . . . . Of the Ui Cormaic are the two Sinells, viz., Sinell son of Cenanan . . . . and old Sinell, son of Corcran, &c."

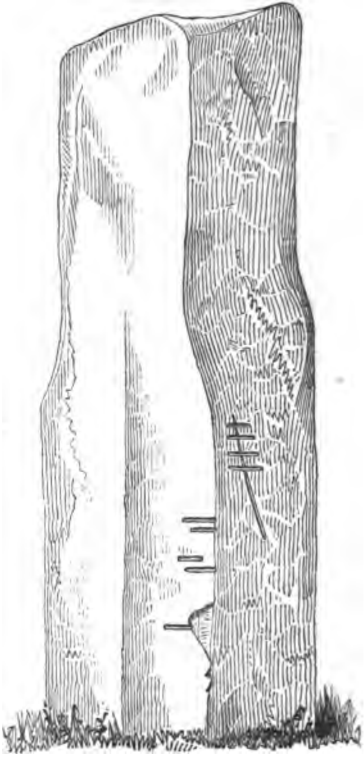
Fig. 3.



Crossing the mound, and over the site of the church, on the plateau at the north-east, stands an oblong, rough, flag-like stone, three feet nine inches over the surface, and about two feet wide, having a plain cross, incised by wide shallow lines, twenty-two inches long by fifteen across the arms.

There are some such flags in the neighbourhood—at Dunboyke and Kilranelagh—and likely belong to a very remote period, as they have not any of the characteristics of mediæval art. Near this is another pillar stone, not more than 2½ feet above the surface, on the top of which is to be seen an indentation resembling the trace of a dog's paw, as if impressed on a very soft surface. This stone was excavated from some depth, but any traces of scores or inscription were not recognised. Some years ago it was much higher above the surface, and its sinking is likely due to carelessness in making the graves, which lie about in profusion. A very curious legend is told about this stone. Tradition says that it marks the grave of Cormac King of Munster, whose name is an affix to that of the cemetery where he rests; it moreover states that he was carried to Killeen Cormac by a team of bullocks, which were allowed to follow their own instinct—a mode of settling disputes regarding sepulture not uncommon among the ancient Irish. The same tradition, though unable to state at what period or under what circumstances King Cormac died, avers that he was carried through Ballynure, from the direction of Timolin, in the county of Kildare; and when the team reached that part of Ballynure known as The Doon, the bullocks, in the eagerness of their thirst, pawed the earth, and that water issued forth. Another version states that the teamster struck his goad into the ground, and thereupon gushed up a bubbling fountain, which is still to be seen near the roadside, and is used as a watering place for the herds of the fertile pastures of The Doon of Ballynure. The bullocks, having satiated their thirst, journeyed on till they came to the place now called Bullockhill, beside the Griese, and opposite to Killeen Cormac. Here they halted, and would proceed no farther; so that Killeen was thus determined to be the last resting place of King Cormac. The bullocks, having performed their part, returned homewards across the marsh beside the river, and tradition states that they were swallowed up in the Griese.

Fig. 4.



Another legend puts a hound on the team, and makes him jump from Bullockhill to the cemetery, and there alight on this stone, and leave on it the impress of his paw—thus marking out the grave of Cormac. It may be remarked that this part of the legend looks like an interpolation from one still more ancient, concerning the hound of Cuglas, from whom Baltinglass derives its name.* He was master of the hounds to "Ederscel, the great King of Erinn," whose dogs indeed must have had paws of steel to impress their traces on full many a rock from Baltinglass to the banks of the Liffey.†

This very curious legend led to various investigations concerning this King Cormac. He could not be Cormac Mac Cullinan, King and

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* Vide *Dinnsenchus*, Book of Lecan.

† Vide Irish version of Nennius, and A. Soc. Tracts, p. 117, for a somewhat similar legend of King Arthur's hound.

Bishop of Cashel, who was slain at Beallaghmoon, in Moyailbi, in the year 908. Keating,* in his account of this engagement, states that Cormac, having a presentiment of his fate, desired to be buried in Disert Diarmid (Castledermot), in case his body could not be conveyed to Cloyne, as Disert Diarmid was the church of his friend and preceptor, the Abbot Snegdus.

There was, however, in this same fatal field of Ballaghmoon another Cormac—Cormac Mac Mothla, Prince of the Desies of Munster—who fell while in command of the left wing of the army of Munster. He may have been the Cormac of the legend in question. The tradition of the locality did not then come to the rescue. The writer, however, met some time after this a gentleman lately returned from New Orleans, who formerly lived in the neighbourhood of Killeen Cormac, whose father was a repertory of local tradition. He told his son, the informant, that the king who gave his name to Killeen was Cormac Mac Melia, King of Munster. In another interview the writer asked him if he could tell what part of Munster he came from, suggesting at the same time Desies, which his informant recognised as the name told him by his father. He had thus no small satisfaction in being able to unravel a tradition corroborating a fact of very great historical interest, if the tradition may at all be relied on.

It has been suggested that the story of the bullocks is not recorded of any except those whom public estimation has placed in the category of sanctity. While admitting the force of this suggestion, the legend in this instance appears to be very coherent, and free from vagueness.

Though it appears that Cormac Mac Cullinan had obvious reasons for selecting Disert Diarmid (Castledermot) as the place of his sepulture, that church may not have had the same attractions for Cormac Mac Mothla, and he likely selected the more ancient, and perhaps more honoured, cemetery of Killeen for the place of his burial, to which in the course of time his name may have been affixed, perhaps to distinguish Killeen from another old and curious cemetery, about two miles to the west of Killeen Cormac, and now known by the name of Kyle; or perhaps there may have been a contention between the rival churches for the honour and emolument of giving sepulture to the remains of a veteran warrior; or it may be that Cormac's friends, following an ancient precedent, may have allowed animal instinct to settle a dispute which the obstinacy or cupidity of rival interests could not have otherwise settled.

In the Life of St. Abban† there is a legend concerning his sepulture, in which bullocks are made to play a very prominent part, and the fate of these bullocks was one nearly similar to that detailed of the bullocks in the Killeen legend. It is also a curious coincidence that St. Abban is called Mac hua Cormac, being descended from an ancestor of that name, who is said to have been a king of Leinster.

---

* *See* Dr. John Lynch's Latin translation of Keating, in a note to the "Annals of the Four Masters," vol. ii., p. 564, Dr. O'Donovan's Edition.

† Colgan, "Acta SS. Hib." xvi.; Martii, cap. xlvii.

In the appendix to this life, Colgan enumerates more than sixty persons of this name who were eminent for sanctity, among whom appears Cormac hua Lethain, the Abbot of Durmagh, and friend of St. Columkille, who met with a tragical fate in that territory which is now the southern part of Kildare.

It has been suggested that Killeen Cormac may be no other than the *Kil-Fine*, or Ecclesia *Fine* of the various Lives of St. Patrick, and the third church the foundation of which is referred to Palladius. A great many indirect arguments may be adduced to sustain this opinion. As the writer has made these churches a special study, and alighted on some interesting relics in the localities in which they are said to have been founded, he hopes to be able at a future period to mature his views on this subject, and to gather new facts, and evidence to sustain them, which will be found satisfactory and intelligible; and he trusts that stronger evidence and future investigations will make it possible, to connect these very remarkable and unique monuments with the names of Palladius and Dubhtach mac ua Lugair—a personage celebrated in connexion with our early ecclesiastical and national records, and in whose history and acts the recent publication of the "Senchus Mor" must awaken no inconsiderable interest.

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THE DUBLIN
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CONTAINING PAPERS READ BEFORE

THE ROYAL DUBLIN SOCIETY; THE ROYAL IRISH ACADEMY;
THE ROYAL GEOLOGICAL SOCIETY OF IRELAND;
AND THE NATURAL HISTORY SOCIETY OF DUBLIN.

Edited by
THE REV. SAMUEL HAUGHTON, M.D., F.R.S.,
FELLOW OF TRINITY COLLEGE,
AND PROFESSOR OF GEOLOGY IN THE UNIVERSITY OF DUBLIN.

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XXII.—OBSERVATIONS ON THE GENERA CYLINDROCYSTIS (MENEGHINI), MESOTÆNIUM (NÄG.), AND SPIROTÆNIA (BRÉB.), (= PALMOGLŒA, KÜTZ. PRO MAXIMA PARTE), MAINLY INDUCED BY A PAPER BY DR. J. BRAXTON HICKS, F. R. S., F. L. S., ON THE LOWER FORMS OF ALGÆ.* By WILLIAM ARCHER.

[Read before the Natural History Society of Dublin, May 5, 1865.]

IN a paper which I had the honour to read before this Society, in the Session preceding last, on the Genus Palmoglœa (Kütz.),† I took the opportunity to bring before your notice the Irish forms of that genus; or rather, those forms which by Kützing would have been referred to it, but which, as I then stated, and as I still apprehend, belong more naturally to several individually distinct but closely related genera. I gave at the same time what may be called, in some measure, an analysis of the genus Palmoglœa (Kütz.), with regard to at least the majority of the forms therein included by that algologist.

Dr. Hicks does that communication the honour of a special paper, in which he expatiates at some length on the validity of the characters which may seem available for the classification of the "unicellular" Algæ, and in doing so he touches upon some of the points alluded to by me.‡ This able observer has had large experience amongst those humble forms; and I have always perused his communications with all the attention to which they are so eminently entitled, and with all the interest they are always so well calculated to excite, as well as with all the gratification their richness in novel information is sure to impart.

The paper in which Dr. Hicks does my previous one the honour of a notice abounds with observations full of importance, and in it he propounds many pertinent queries. As he, however, differs with me in some of the opinions put forward in my paper, which indeed I do not yet see reason to change, and as I am, on the other hand, quite disposed to agree in a great measure with him on certain other points put forward by him, though not referred to by me in my previous paper, I may perhaps be allowed again to offer a few observations on the subject.

But I must *in limine* contend, inasmuch as my paper was not on Palmellaceæ in general, but on the genus Palmoglœa (Kütz.) in particular, that much of the reasoning and many of the questions propounded by Dr. Hicks do not therefore apply to, nor do they, I think, at all controvert, my therein expressed views. And it is for this reason that I say I venture in some points to disagree from, and in others to agree with, Dr. Hicks; for if we conceive Palmoglœa (Kütz.), or, more properly speaking, the three genera, Cylindrocystis (Meneghini), Mesotænium (Näg.), and Spirotænia (Bréb.), which indeed were the actual subjects of my paper, to be eliminated from the question, I think I must in a measure acquiesce in his views, though without at all consenting as yet to accept them in the aggregate.

---

* "Remarks on Mr. Archer's Paper on Algæ," in "Quarterly Journal of Microscopical Science," N. S., vol. xii., p. 253.

† "Proceedings of the Natural History Society of Dublin," vol. iv., p. 12; also "Quarterly Journal of Microscopical Science," N. S., vol. iv., p. 109 (1864).

‡ "Quarterly Journal of Microscopical Science," N. S., vol. xii., p. 253.

Dr. Hicks puts forward the title of my paper—"An *Endeavour* to identify *Palmoglœa macrococca* (Kütz.)"—as, in itself, some argument for the want of stability in the Palmoglœan species. Considering this uncertainty as regards these forms as unquestionable, he would from them, as a starting point, argue as regards Palmellaceæ generally. It is true that he attacks the independence of many of that family elsewhere on far better grounds; and it seems to me that arguments against the independence of the species of Cylindrocystis, Mesotænium, and Spirotænia would at least be more forcible if made through the Palmellaceæ, than are arguments made against the Palmellaceæ in general based upon the forms included in the three genera mentioned. For, irrespective of the question of the Palmellaceæ in general, I believe, at least as far as present knowledge goes, that these three genera seem to hold themselves quite distinct, and their species to reproduce themselves by what I must regard as a true generative act. And that I entitled my paper "An *Endeavour* to identify *Palmoglœa macrococca* (Kütz.)" seems to me not to conflict with this view, nor at all to indicate that I thought it did. If Kützing's descriptions of these forms are so scanty, and his figures so defective (I say it with all deference, and with much reverence for so indefatigable and experienced an observer)—if the diagnoses for the species given by him are but superficial, and the intrinsic and peculiar characteristics of the forms neglected—what else *could* it be but an endeavour to identify recent living examples with his? Is not, indeed, like difficulty often experienced in identifying species from descriptions, and especially if accompanied by insufficient figures, in other departments of nature, where many and more readily available characters and more tangible holdpoints present themselves, but which difficulty would probably be removed by the inspection of fresh authentic specimens? The difficulty of identifying those particular forms ranking themselves under the three genera in question with those from which Kützing wrote his descriptions does not, I apprehend, in itself speak against their individuality and distinctness; and the species themselves included in these genera are indeed, after all, but few. It is true that Kützing himself, even in regard to Algæ far higher, and as to some of which an elaborate reproductive organization is now known, considered them, not *species* (I mean in the commonly understood old sense, and as Kützing himself would doubtless apply the word to the higher plants), but as merely *forms*. Yet, even in "Palmoglœa," Kützing recognised the differences from his specimens, though I think he fails to seize upon those of importance, or successfully to pourtray them either with his pen or pencil.

Again, Dr. Hicks seems to say, because the plant (distinct in itself at least) which I would refer to *Palmoglœa macrococca* (Kütz.) truly belongs to Mesotænium (Näg.), one of several genera into which the genus Palmoglœa (Kütz.) should be divided, that such a circumstance in itself would seem to argue for the complete uncertainty of any of the forms included by Kützing in his genus. If we have now a more accurate knowledge of the individual forms of Kützing's genus and their intrinsic characteristics, than that distinguished algologist appears to have had when he wrote, perhaps from his not having always examined living specimens, it is surely not very wonderful that it should be necessary, or at least that it should be advisable to redistribute certain minor groups of them, agreeing in certain common characters, into other genera. In order to illustrate this, indeed, I need but refer to the old multifarious genera, Conferva and Lichen. Because the incongruous species formerly included in these old, and as we now know unnaturally comprehensive, genera, have had to be parcelled out here and there according to the special characteristics and affinities of each, notwithstanding blanks in our knowledge as regards even many of the smaller groups, it has not happened that this task has been in many respects, or on the whole, quite a hopeless one. Nor do I think, so far as I can see, that the breaking up of the species of the genus Palmoglœa which fall under Cylindrocystis, Mesotænium, and Spirotænia, has been quite unsuccessful; nor can I see how the advisability of the step can in itself be adduced as an argument as to the uncertainty of those forms, but should rather regard it as a natural consequence of their characters being happily better established; the others formerly included in Palmoglœa have to be carried elsewhere—one I think, at least, to Chroococcaceæ; and their true nature, I quite admit, does not seem at all so well established.

Further, Dr. Hicks goes on to remark:—"If by one observer the envelope of mucoid matter be taken as a specific or even generic sign—if the mode of segmentation be taken by another as of specific or generic value—if the size of the cell, or the position of the nucleus, or the mode of diffusion of the endochrome within the cell, be sufficient in the eyes of another to separate genera—if, as Mr. Archer contends, the oval shape is another important distinction—it seems to me no wonder that the difficulty acknowledged by all has arisen." These remarks are intended to be applied to the genus Palmoglœa; and I quite acquiesce with their author, that no wonder the difficulty adverted to should have arisen, when each single observer pays attention to one only of such characteristics, disregarding all the rest. The genera Cylindrocystis, Mesotænium, and Spirotænia (which are those in question), each, it is true, possesses an envelope of mucoid matter, but it indeed exists also in many Palmellaceæ, as well as Chroococcaceæ, likewise in Desmidiaceæ, &c. The transverse mode of segmentation—that is, through the shorter diameter—occurring in these genera, takes place also in Desmidiaceæ, in the elongate forms of Palmellaceæ, as well as of Chroococcaceæ. The oval shape, too, is shared by the forms in question with several other forms in both those families. The size of the cell likewise varies in these plants, within certain limits, in the same species. The nucleus is very hard to be made out—indeed, I doubt if it is always to be perceived or existent even in Palmellaceæ. Nevertheless, I hold that the forms in question are abundantly distinct; and that, when the eye becomes familiarized with them, they can be at once recognised. It is, of course, here as elsewhere, on the special characters possessed in common by certain groups of the species, combined with certain of the foregoing general characters, and not upon any one or more of the general characters, as suggested by Dr. Hicks, that we must rely as of generic value, and on the ultimate individual proper characteristics of the forms themselves as of specific importance. The special characters, which, as I think, here determine the genera, exist in the peculiar arrangement of the contents, combined with certain of the general characters previously alluded to; whilst I believe the specific characters reside in the peculiar form of the cell, and in minor differences in the arrangement of the contents, and in difference of colour, &c., perceptible to the unassisted eye in the general mass or stratum.

Again, Dr. Hicks seems to convey, because of the difficulty (for the reasons before stated) of assigning some of these forms to the particular ones described under Palmoglœa by Kützing, and from there having been actually (as I conceive) included under that common generic denomination five diverse types, that therefore "no one algologist can tell distinctly what is a Palmoglœa, so as to be understood by any other algologist." I venture deferentially to deprecate this, as it appears to me much too hasty a conclusion. I must, in reply, urge that if many of the now well-established species formerly comprehended under the old incongruous genus Conferva were still referred to under their original designations, and recent researches upon the forms alluded to momentarily forgotten or ignored, that it is still more probable no one algologist could, under such circumstances, tell what was meant by another algologist. But, if our plants be closely examined from the living examples, and de Bary's descriptions and figures thereof carefully studied by any two algologists, I hardly think there will be any difficulty between them in understanding what the other means when he refers to a Cylindrocystis, a Mesotænium, or a Spirotænia.

Dr. Hicks does not see how I can find sufficient ground to state that the condition of a developing lichen figured by him is not a "macrococca"—that is, as I am disposed to think more correctly designated, an example of *Mesotænium chlamydosporum* (de Bary). I judge from the figure; and I think, as I stated, because it seems to me, so far as I may venture to judge, to represent something at once sufficiently unlike both the form with which I am acquainted, as well as Kützing's description and figures of his *P. macrococca*, as to justify me in that assumption.

Again, as if it were to a certain extent evidence of the total instability of these forms, Dr. Hicks alludes to my being by no means certain what he means by *Palmoglœa Brebissonii*, because I questioned whether the plant he has in view as *Palmoglœa macrococca* is the same as *Palmella cylindrospora* (Bréb.), considered by Mr. Ralfs as equivalent to his *Penium Brebissonii*, and of which Dr. Hicks writes:—"So far as can be ascertained, Mr. Thwaites calls *Coccochloris Brebissonii*, although Mr. Archer thinks he means *Trichodictyon rupestre* (Kütz.); the exact characters of this form, it will thus be seen, are by no means settled by any one of these observers." Dr. Hicks writes, indeed, "this form;" but the supposed confusion is partly accounted for by the fact, that there are two distinct forms referred to under the foregoing names, and two forms which, as I hold, when once seen cannot readily again be confounded; for, even though the characters assigned to each should not be found presenting themselves in every specimen with absolutely unmistakeable clearness, that is, if unhealthy or deteriorated specimens should again come under consideration—yet I believe a certain *tout ensemble* will, even under such circumstances, readily satisfy the eye familiarized with their appearance in their ordinary and healthy condition of their distinctness *inter se*. The plants adverted to under the names quoted by Dr. Hicks, but adopting here the names which I regard as the correct ones, are *Cylindrocystis Brebissonii*, Meneghini, and *Cylindrocystis crassa*, de Bary. Dr. Hicks, indeed, says, as I have quoted, that "the exact characters are by no means settled by any one of these observers." I may venture to refer to my own previous efforts to describe their generic characters, and I can only appeal therefrom directly to the fresh specimens themselves.

Dr. Hicks writes that—"The question, first of all, arises, how is a single cell to be distinguished from another single cell? What reliable characters are to be fixed upon which can be considered as of generic value?" If he propounds these questions as regards the old genus Palmoglœa, or rather as regards the three genera already quoted, I should have ventured to think that my previous paper was an answer in anticipation. Though in a diffuse way indeed, I think the descriptions there given may be found to contain the characters enabling an observer to decide to which, *if* to any, of the three genera, Cylindrocystis, Mesotænium, and Spirotænia, a single cell belongs. Dr. Hicks asks—"How can we tell whether it be a fixed form, a separate entity, or merely a transitional form of some other growth?" Again I venture to reply, if this question be put as regards the forms immediately under consideration, that I should be disposed to say (so far, I think, as our present knowledge goes), that a sufficient answer is, that they each reproduce their like by a conjugative act, thus renewing the species. For, inasmuch as conjugation must be looked upon as a true generative act, as I regard it, we must suppose that this takes place when the plant has reached the end of its existence, and has arrived at the ultimate stage in its history—that is when it is at maturity—each of the conjugating pair of cells surrendering individual existence in giving origin, by the union of their contents, to the spore from which is to be evolved the primordial individuals of the next generation.

And this leads to an important point in the argument, bearing on the difference of opinion between Dr. Hicks and myself on the matter immediately in question—I mean, the value or import to be attributed to the conjugative act, as to which point I feel bound altogether to agree with Professor de Bary.*

Dr. Hicks considers it "merely an act of fusion"—that is certainly a brief but true definition of the simple act in itself; but it is not the *modus operandi* of the mere act that is in dispute, but the physiological significancy or import of that act. From his saying that is "*merely* an act of fusion, not of impregnation,"† I infer that he conceives that it has no special significancy. But can a phenomenon which has been going on for years and years uncountable, since Conjugatæ were—restricted, with a few exceptions, as it is, to the group so denominated, and the Diatomaceæ—be simply accidental, and quite devoid of all significancy? I cannot believe it reasonable to suppose that it should be so.

I believe that the phenomenon of conjugation can be regarded as nothing less than an indication of a distinction between germ-cell and sperm-cell, the humblest manifestation (it may be) of a difference of sex, which becomes by degrees more and more forcibly pronounced in the higher organisms, yet in none more firmly established, nor more conclusively settled, and that by direct observation, than in some of the lower Algæ, which, by reason of their simple structure, range themselves (along with the Conjugatæ) in the group of Confervoideæ. It may be urged, indeed, that the conjugating cells show no so great differentiation either in organization, dimensions, or appearance, as do the spermatozoids of those Algæ in which they have been discovered, from the germ-cells which it is their function to fertilize. This to a large extent is granted; but, nevertheless, a certain amount of specialization of certain conjugating cells in some forms does occur, pointing to something more than a mere fusion, without any significance. Indeed, the conditions which accompany conjugation in the different forms present a series, in their way, almost as varied as do the germ-cells and spermatozoids of other Algæ—not so pronounced, it is true, but still pointing, I think, to an analogy.

It will be proper, in pursuance of the argument, to advert to some of the varied examples; but, in the first place, it will be advisable briefly to draw attention to certain cases where a true fertilization has been proved in other Families, and then to compare that act and its results with some of the Conjugatæ.

In Vaucheria there exists a large globose germ-cell, and exceedingly minute, very numerous elongate spermatozoids, both elements of the fructification originating in neighbouring specially formed branches of the tubular filament, these not distinguishable at their first commencement from one another, or indeed from ordinary branches, though afterwards so highly differentiated. Here the difference in form and size between the germ- and sperm-cell is very great, and the resultant spore developes directly into a new plant. The difference of opinion between observers (Karsten,* Pringsheim,† Dippel‡) as to the *modus operandi* of the fertilization in this genus does not seem to bear on the immediate question; for, whether the "hornlets" (antheridia) actually inosculate with the openings of the oogonia or not, the essential circumstance seems to be the union of the contents of the two organs. I certainly never have encountered any Vaucheria in which any such inosculation of the two organs seemed to exist, and Pringsheim's account appears to be the most trustworthy.

---

* "Untersuchungen über die Familie der Conjugaten."

† "Quarterly Journal of Microscopical Science," N. S., vol. i., p. 18.

Again, in Sphæroplea the cell-contents of the very long ordinary joint of a particular filament become broken up into a number of rounded germ-cells; and the contents of another ordinary joint become broken up into an innumerable number of little biciliated subfusiform spermatozoids, which latter find their way out of their parent cell, and into the cavity of the joint which contains the germ-cells, through lateral openings in each. The fertilized oospore eventually developes two coats, the outer beset with spine-like extensions. Here the difference in size and appearance between the germ- and sperm-cells is less than in Vaucheria, whilst the resemblance of the parent cells in which they originate is still greater, being in fact but two ordinary, in no way previously specialized, joints of the filament.§

In Œdogonium, varied as are the conditions between monœcious, gynandrosporous, and diœcious, under which the essential elements concerned in the reproduction present themselves, there seems to be still less difference, on the whole, in form and size of the spermatozoid and the oogonium themselves, than in the other cases adverted to.

In *Œdogonium curvum* but one spermatozoid is formed in each antheridium cell, and, like the oospore, it is globular; and although there is a considerable difference in size between the two, in this respect they much more nearly approach than in the previously cited cases—that is, though of course equally physiologically distinct, they are more nearly morphologically equivalent. In Œdogonium, Cleve has shown that the oospore in germination produces, by segmentation of its contents, four daughter-cells, which become ciliated, and swim away as zoospores to reproduce the species;[*] while for Bulbochæte, whose fructification is gynandrosporous, Pringsheim had previously shown that here also four daughter-cells are developed from the oospores, which become zoospores, and reproduce the plant.[†]

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* Karsten, in "Botanische Zeitung," x., p. 85 (1852).

† Pringsheim, in "Berichte der Berl. Akademie."

‡ Dippel, "Ueber die Fortpflanzung der Vaucheria sessilis" in "Flora," 1856, pp. 481, 497.

§ Cohn, "Berichte der Berl. Akad.," 1855; also "Ann. des Sciences Naturelles," 4 Ser. v., p. 187; and "Ann. Nat. Hist.," 2 Ser. viii., p. 81.

These, then, are unquestioned and unquestionable instances of a true generative act. It would be useless, as regards the subject under consideration, to travel out of Confervoideæ for further illustrative cases where a true reproduction is effected by spermatozoids and oospores, because we should be unnecessarily receding in the system from Conjugatæ.

Now, in the cases which I have just so briefly alluded to, more or less varied as may be the accompanying conditions, simple or complex, or more or less specialized as may be the accessory organization, the one pervading essential circumstance in the phenomenon beyond doubt seems to be the material union, the flowing into one, the simple fusion, of at least two primordial cells.

Now, what *less* than this is the act of conjugation in our Cylindrocistis and Mesotænium?

It may be, perhaps, answered that neither of the two conjugating cells is ciliated, and that they are apparently morphologically equivalent—that two cells only co-operate, whilst many spermatozoids may take a share in the fertilization of a single oospore. I can only say that these objections refer to conditions which seem to be in a measure accidental, and unessential in a physiological point of view. The mechanism of conjugation, if I may so express myself, does not require the special organization on the part of the primordial cells engaged in the act, which are found in Vaucheria, Sphæroplea, some Œdogonia, &c. In these, greater or less numbers of ciliated spermatozoids are produced—ciliated, probably, because they have a distance to travel—often in multitudes, to insure that some may ultimately find their way to the oospore; whereas in the Conjugatæ two cells about to conjugate lie side by side, and are mostly joined by an intervening canal, formed by the walls of the parent cells, through which the protoplasmic contents are guided, and pass over by means of their own innate contractility, when acted upon by the marvellous impulse to coalesce the one with the other. Again, as to but two primordial cells co-operating in the act of conjugation, whilst many (the spermatozoids) may unite with one (the oospore) in the other cases cited, the mechanism of conjugation, if no other reason, places a bar to this. I have, indeed, in such free forms of Conjugatæ as Closterium and Staurastrum, seen three individuals conjugated, forming a single zygospore—nay, it sometimes happens in Zygnema that the lateral processes of two joints inosculate with a single joint of a neighbouring filament, three cells thus co-operating in the conjugation. These, however, are quite exceptional, perhaps even abnormal, cases. But this argument, even if adduced, I should regard as quite groundless; as it is, I presume, quite physiologically possible that one spermatozoid might fertilize one germ-cell. Nay, even supposing that it always required the united co-operation of several spermatozoids to fertilize one germ-cell of so much greater volume than one of themselves, might it not be supposed that, by reason of the more nearly or altogether equivalent volume of the two conjugating cells, the force or potency would be sufficient without the co-operation of a greater number, not to speak of the mechanical impossibility in most cases, or of the unnatural dimensions which a zygospore must assume, if formed by the union of a number of so comparatively large ordinary cells?

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[*] Cleve "Iakttagelser öfver den hvilande Œdogoniums-sporens utveckling," in "Öfversigt af Kongl. Vetenskabs Akademiens Forhandlingar," Stockholm, 1863, p. 247.

[†] Pringsheim, "Beiträge zur Morphologie und Systematik der Algen," in "Jahrbücher für wissenschaftliche Botanik," Band i., p. 55.

But, even though it be reiteration of already known facts, in pursuance of our argument, it will be well momentarily to carry on our examination of the phenomenon of conjugation from Cylindrocystis and Mesotænium into other genera of the Family, and briefly to trace some of the modifications displayed, and to consider how far they bear upon the question. In these we find a certain greater or less amount of complexity in the conditions contemporaneous with, and subsequent to, the act, which are so constant in their recurrence as I think strongly to evidence, when we consider it, that the phenomenon is by no means casual or insignificant.

In the first place, in our genus Mesotænium, the process of conjugation takes place by a protrusion and simple fusion of the primordial utricles and contents of each pair of cells, the parent cell-wall slipping off in the act, and becoming discarded, and finally dissolved. The conjugating cells lie in a great variety of positions, and the different zygospores are of course at first of very varying outlines; but eventually they assume externally a subquadrate or elliptic figure, and a proper cell-wall. Again, in Cylindrocystis mutual lateral processes of the two conjugating cells are put forth, which inosculate, permitting the fusion of the cell-contents of each. The isthmus between the two gradually grows wider, until the zygospore, from a form somewhat like an H or an X, by-and-by assumes a subquadrate outline; eventually, the walls of the parent cells giving way at their suture, and becoming by degrees thrown off, the zygospores having acquired a proper cell-wall. In neither genus does the zygospore bear spines. In the germination of the zygospore, in both genera, there are developed four daughter-cells, each of which becomes the primordial individual of a new cycle, thus reproducing the species.

Now, these cases—those of the plants in question, which I have thus so briefly alluded to—seem to present the simplest conditions in which the phenomenon of conjugation occurs. Here the contents of two cells, seemingly morphologically equivalent, and apparently of similar value, become fused into one, outside either parent cell; and it is at least noteworthy that the first result of the fusion of the two distinct primordial cells, as indeed in all cases of conjugation, is the formation of a new cellulose wall round each zygospore produced by the act; and this is precisely what takes place when the oospore in Vaucheria, Œdogonium, Sphæroplea, &c., becomes fertilized by the spermatozoids. Likewise, the circumstance of the zygospore of Cylindrocystis and Mesotænium producing in germination four daughter-cells has its analogy in the same behaviour in the germination of the oospore of Œdogonium and Bulbochæte—which fact thus, so far as it goes, seems to point to the conclusion that in each they are the result of a similar act. The daughter-cells, or primary cells of the following generation, however, in each differ in what I should but regard as a secondary and unessential circumstance, in that, in Œdogonium and Bulbochæte, they are for a time motile, whilst in the parallel degree of developement of the spore of Cylindrocystis and Mesotænium they are, as always, still.

Examples of conditions nearly as simple are presented by many Desmidiaceæ, but also conditions more complex are met with in various species, to enter into detail here as to which would, however, be superfluous. Many of the zygospores become, as is well known, furnished with variously fashioned spine and processes, which circumstance seems to me probably to find a parallel in the less developed ones of *Œdogonium echinospermum.* As is well known, very varied conditions are to be met with appertaining to, and characteristic of, various species. Thus the spinous or non-spinous zygospores—the simple or variously branched spines—the orbicular, or quadrate, or characteristically lobed figure of the zygospore—the relative positions of the conjugating pairs of individuals—the, so to say, double spore of *Closterium lineatum*—the conjugation following immediately on self-division in *Closterium Ehrenbergii, C. Pritchardianum*—the complete and persistent fusion of the parent membrane in *Hyalotheca dissiliens, Closterium parvulum*—the remote outer coat of the spore of *Tetmemorus lævis*, &c., besides minor specialities of detail proper to the various forms—all these can hardly be considered as the accompaniments of an accidental phenomenon, in itself meaning nothing, and destitute of significancy.

But, in pursuing onward our examination of the conjugative process and its results, the behaviour in *Didymoprium Grevillii*, in which species, of two conjugating filaments, the cells of one are always the receiving—those of the other the giving—cells in the conjugative act, leads us to Spirogyra, in which these conditions are constant. In this latter genus the receiving cell frequently assumes an enlarged and different figure, often preparatory to, and in anticipation of, the accession of the contents of the giving cell, thus, I think, exhibiting a certain significant amount of differentiation.

In Spirogyra and Zygnema, as is well known, the act of germination consists in the inner coat of the zygospore expanding and bursting off the outer, and, while extending in length, becoming transversely divided by a septum, the lower cell remaining always undivided as a "root-cell," the upper becoming the first ordinary joint of the new plant, thus differing from Cylindrocystis and Mesotænium. But in this characteristic we have to some extent an analogy in Vaucheria, whose fertilized oospore does not develope daughter-cells, each to give origin to so many new individuals, but grows at once into a single new plant, unicellular, of course, like its parent.

But, notwithstanding all these so varied, more or less complex conditions, it may perhaps be still urged that, after all, such conjugation is but the union of the contents of two morphologically equivalent cells.

To this objection the conditions in the genus Sirogonium seem to afford a valid answer.

Two ordinary joints of a filament in Sirogonium mutually send out short processes, as in Spirogyra, which become united; thereupon there ensues the formation of a septum (similarly to that of the vegetative cell) in each of these united cells. In one, this septum, however, unlike the septum of a simply vegetating cell, divides the mother-cell into two very unequal daughter-cells, the larger of which becomes externally expanded. This larger expanded daughter-cell is that one which bears the extension joining it to the other opposite conjugating cell, and is constantly the *receiving* cell—that is, the one ultimately to contain the zygospore. Its sister-cell—the smaller one—remains sterile, being shut off from participating in the conjugation. The other opposite conjugating cell also becomes divided by a septum into two daughter-cells, a short and a long one; but in this instance it is the shorter daughter-cell to which the extension joining it to the other conjugating cell belongs, and this cell is in conjugation constantly the *giving* cell; its sister-cell—the larger one—remains sterile, being shut off from participating in the conjugation. The shorter or giving cell is itself sometimes again divided into two, one of which daughter-cells is shut off from participating in the conjugation. Speedily the contents of the two connected cells become increased in quantity and density, so as more nearly to fill the cells, quite unlike the sparse pale (yellowish-green) and narrow irregular bands formed by the endochrome of the simply vegetative cells. The contents of the two conjugated cells now become contracted from the cell-wall; the intervening septum of the tubular inosculated connecting processes becomes resorbed; the contents of the smaller of the two passes over, as in Spirogyra, and becomes formed, within that of the other, incorporating with its contents, into a zygospore.

Here, then, is a conjugation between two cells *not* morphologically equivalent, but which are evidently specialized structures. Here the giving and receiving cells seem to be as morphologically distinct as in *Œdogonium curvum*, in which the antheridial cell gives birth to a single spermatozoid, not much smaller than the oospore, the main distinctive circumstance being, that in the latter the fertilizing cell is ciliated, making its exit from one, and its entrance into the other, parent cell, by an opening in each, whilst in the former neither is ciliated; and, besides, the parent cells being apart in the one, and joined together by a firm inosculation in the other.

It being admitted, then, that this case is one of a true generative process, the reproductive elements being seemingly well differentiated as germ-cell and sperm-cell, the transition downwards through the various forms of Conjugatæ is easy and natural to our Mesotænium and Cylindrocystis; and it seems to compel the admission that the process in all is a manifestation of one and the same phenomenon, with one and the same import.

But it may be further objected, that in many of the Conjugatæ spores or spore-like bodies very similar to the true zygospores, and from which young plants may be developed, are formed without any conjugation at all. However, it seems to me that these bodies may bear a relationship to the ordinary zygospores, the same as that of the ordinary zoospore of Œdogonium and Bulbochæte to the four zoospores evolved from the fertilized oospore; and both bear to the plants which produce them an analogy similar to that of the buds, bulbils, &c., of higher plants to their seeds. As to the so-called "Asteridia" (Thwaites), "Asterophæria," "Spermatosphæria" (Itzigsohn), &c., they are most probably parasitic growths, and their true nature is as yet not at all understood.

But Dr. Hicks intends his queries, first applied to Palmoglœa, to be extended to certain true Palmellacean forms; and, if applied to some of the lower forms of which, I am free to own that they cannot be so easily answered, nor can his objections be so readily met.

There is a point, however, which seems to be overlooked by Dr. Hicks, and a consequent confounding of two apparently essentially distinct groups fallen into. Dr. Hicks seems to ignore the Family Chroococcaceæ as distinguished from Palmellaceæ; thus, forms appertaining to Chroococcaceæ are sometimes, as it appears to me, indiscriminately spoken of as originating from some higher plant, whose endochrome is chlorophyll, and *vice versâ* as regards Palmellaceæ. Now, in so far as we know, it seems a matter not at all to be expected that such a transformation should take place; that is, I should be disposed to hold it exceedingly unlikely that a chlorophyll-bearing lichen or moss should produce a phycochrome-bearing Glœocapsa, and that too along with a chlorophyll-bearing Palmoglœa. Thus *Glœocapsa polydermatica* surely belongs to Chroococcaceæ, and could not be regarded as proceeding from a chlorophyll-bearing lichen. A Glœocapsa-form may possibly originate from a phycochrome-bearing lichen—for instance, a Collema; and I venture to think that in many cases where Dr. Hicks speaks of Palmellaceæ, he means to refer to Chroococcaceæ. Many of the forms included amongst the latter, I am myself greatly disposed to think, show a considerable amount of instability, and may probably be but transitory or developemental stages of higher plants. But then they must, I think, at least owe their origin to phycochrome-containing plants—some, for instance, may be early stages of Scytonemeæ. On the other hand, many of the forms seem to be very recognisable, and are frequently met with, season after season, precisely like their predecessors, and under the same circumstances; and one can often at a glance tell that a certain form under observation is exactly the same thing that one has seen before. But this would not in itself be an argument that they may not be, so to speak, if the phrase be at all admissible, "alternations of generation" of certain Lichens or of Scytonemeæ. In regard to Palmellaceæ, such genera as Pleurococcus, Glœocystis, and Palmella, if they are all actually but developmental stages of higher forms, could at least originate only from chlorophyll-bearing plants.

But, further, on the other hand, many of the Palmellacean genera produce a very definite structure, even what may be called a frond, and sometimes very definite forms of the individual cells themselves. So readily do these specialities strike the eye when once they have been seen, that on their recurrence they are at once recognisable. The generic names Apiocystis, Schizochlamys, Palmodactylon, Tetraspora, Monostroma (Ulva in part), Dictyosphærium, Oocardium, Hormospora, Nephrocytium, Mischococcus, Ankistrodesmus (Rhaphidium), Polyedrium, Cystococcus, Dactylococcus, Characium, Ophiocytium, Scenedesmus, Pediastrum, Cœlastrum, Sorastrum, Eremosphæra, and many more, all call to mind, in a moment, forms which, some rarely, some frequently, present themselves to notice, and maintaining their characteristics, while at the same time no true generative process has been discovered, reproducing themselves by diverse modes of cell-division, by zoospores, by "brood-families," &c. They are also found maintaining their characters in various places; and I think it is not readily conceivable what varied accidental concatenation of circumstances could, in so diverse localities, force a certain supposed gonidium of a lichen or spore of a moss now to develope into this well-defined form, now into that. Therefore, if, on the one hand, such genera perhaps as Chroococcus, Glœocapsa, Synechococcus, Glœothece (in Chroococcaceæ) and Pleurococcus, Glœocystis and Palmella (in Palmellaceæ), seem, from Dr. Hicks's researches, to be in jeopardy, it surely appears to me as yet, not to speak of our Cylindrocystis, Mesotænium, and Spirotænia, that it would be an incautious and too hasty conclusion to sweep away all "Palmellaceæ." Mere resemblance is not necessarily identity.

Dr. Hicks puts some queries as to the value of certain characters of cells, as affording clues to their affinities—that is, as to their use in a classification. Certainly no one character can in any case be regarded as decisive; nor is such to be expected. A combination of all, however, makes up a certain *tout ensemble*, which often tells us that it is, at least, the same form or phase of developement one has seen before.

Size of the cells? It no doubt varies within certain, often characteristic, limits.

Position of nucleus? or of a starch granule or a "vesicle"? The former is seldom discernible, and it can, on that account, rarely be of use; the latter, how constant and characteristic in certain Desmidians, and many other Confervoids.

Disposition of chlorophyll? This is in certain stages of very many forms a most useful character, *e.g.*, Hormospora, Ophiocytium, Conjugatæ at large, &c. &c. Dr. Hicks, indeed, supposes the case of "Zygnema" (properly Spirogyra), in which the contents in conjugating lose their spiral arrangement, and become "homogeneous;" and then he says—"Supposing subdivision to take place, the contents of the resulting cells would become more or less homogeneous, and thus the spiral character lost." But this is not what takes place. The spore casts off its outer coat, and the inner one elongates, of which, upon dividing, the upper cell becomes the first ordinary joint of a new filament, and the spiral arrangement of the chlorophyll is resumed, the lower remaining undivided as a "root-cell." There is, indeed, more of a characteristic uniformity in the disposition of the phycochrome in the Chroococcaceæ.

Form of the cell? This is surely in many instances of the greatest value. Dr. Hicks points to the Plate illustrating my own former paper as an example of the instability of this character. But I hardly think it is a conclusive argument against the value of this character to regard a plant in the varying phases of its developement, and say that, because such differ, that *form* is of no value. The phases of growth should be taken, and the comparison made, at the same point in developement; for very varied phases may certainly intervene, nor does this latter fact seem to me to conflict with my view. The zygospore of *Penium Mooreanum* figured on the Plate referred to, or indeed that of any other Desmid or Conjugate, or that exceptional phase of Mesotænium, or the oospore of an Œdogonium, or even the zoospore of a Cladophora, or of a Drapernaldia, &c., are not more unlike, after all, to their parent or mature forms than an acorn is unlike an oak.

Dr. Hicks further writes—"The varying forms of their divisions show that their form changes very strangely. This is observable in almost every Conferva, and the Desmidieæ are good examples." I do not quite comprehend this. If a cell of a Conferva or a Desmid during division is not actually of the same figure as one fully-grown, surely it attains it when the process is completed. If he means that a Conferva or a Desmid during the act of division is able to change directly from one form to another, I hold that this is wrong, and that there is no foundation for such an assumption. Nay, "the varying forms of their divisions" seem rather in themselves to afford more or less useful characters.

To pass on briefly to consider the communication from Dr. Wallich which I have just had the honour to read to the Society (*vide infra*) he, while contending for the greater or less instability of the Protophyta, the Desmidieæ included, does not, however, make such a demand as that just adverted to. I shall, as the opportunity here occurs, venture to add a word or two in allusion to Dr. Wallich's communication, referring mainly as it does to certain Desmidian forms. I have, indeed, ere now endeavoured to express my own views as fully as I could on this point; therefore I shall not here attempt to dilate at any length on the subject, as it would be but repetition.

In the first place, then, Dr. Wallich alludes to my urging the persistence of type in the Desmidiaceæ, because they are more or less constant in a given locality. On the other hand, he urges that, unless these characters are found to occur under every variety of conditions he cannot accept them as evidence of the persistence of type for which I have contended. Now, it seems, at first sight, that it is asking somewhat too much to demand that every variety of conditions should produce no effect, when it is only under certain conditions that some forms are found at all. But he explains that by "every variety of conditions" he means "in widely remote localities." It will be admitted, I think, that the West, Centre, and North of Europe are widely remote localities, yet from these far apart sources the same Desmidian forms have been collected, maintaining their special characters. In his lately published list of Desmidiaceæ collected in Sweden, Cleve,* while he truly enough says the specific distinctions are often founded on minute differences, states that he never found any difficulty in identifying the forms he met with with those of other countries by aid of dried specimens and figures, and he enumerates a goodly catalogue. I myself have seen some examples from other parts of Europe. Nay, I may appeal to Dr. Wallich's paper on Desmidiaceæ, collected in Bengal,† where he recognises, and is able to name from their own special inherent intrinsic characters, several of the species belonging to Britain; thus, not only from still more widely remote localities, but under circumstances of climate greatly varying from that in which the same species occur here. It is true that, in regard to several of the forms which I should be disposed to regard as abundantly distinct, Dr. Wallich would often combine several of such into a single species, under a common specific designation; but yet this does not militate against this part of my argument: for he was still able to identify the forms by their intrinsic characters there as here, although he holds a different view from that which I have hitherto found myself compelled to adopt, as to the value of those characters.

Dr. Wallich thinks, "that in these forms such differences as the number of indentations, the acuteness or obtuseness of the teeth, the number of spinous processes, and so forth, indicate mere accidental variations." But these very characters, thus succinctly recapitulated, according to the degree and mode in which they are presented, are amongst the most available holdpoints for the discrimination, not of species alone, but also of genera. In what does a Micrasterias differ from a Euastrum, a Staurastrum from a Cosmarium, &c. &c., but in the mode and way, the degree and extent, in which these characters, and characters such as these, are presented—not to speak of the various forms within those genera which Dr. Wallich goes so far as to allow are really good species. Dr. Wallich, for instance, calls such forms as *Micrasterias rotata*, and *M. denticulata*—*Euastrum didelta*, and *E. ansatum*—as in each case but varieties of a single species, &c. Why admit certain denticulations, and incisions, and processes, and lobes in these forms to be good specific marks, and then arbitrarily stop short, and disallow other characters of the same nature possessed by one of the disputed forms, and not by the other, and which each refuses to lend to the other, and say they are of no value—although, so far as we know, the species depending on them can be recognised wherever the two forms are found in various countries of Europe, and in Bengal?

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* Cleve: "Bidrag till Kännedomen om Sveriges söttvattensalger af familjen Desmidieæ," in "Öfversigt af Kongl. Vetenskaps-Akademiens Förhandlingar;" Stockholm, 1865, p. 481.

† "Annals of Nat. Hist.," 3rd Ser., vol. v., pp. 184, 273.

Dr. Wallich believes that "such differences indicate mere accidental varieties, handed down, no doubt, from parents to progeny in the same locality, so long as physical conditions remain the same." If certain external physical conditions be the cause of such minor individual characters, and if dissimilar conditions will cause their obliteration or transference, how is it that, under all conditions in which *Micrasterias rotata* and *M. denticulata* (for instance) present themselves, they maintain, at least so far as we know, their own ultimate characters? With us here they are both about equally common in their own localities. It is clear that the greater number of subdivisions of the former, its larger middle lobe, its more acute teeth, its greater size, &c., give it no advantage over the latter in the "struggle for life," although both have the preponderance in numbers (in whatever the advantage may consist) over certain other well-marked allied forms. I think it seems to follow from Dr. Wallich's statement of his views, that "natural selection" must in his opinion fall into the back ground so far as these organisms are concerned; for, according to him, characters derived from parents, however seemingly inherent here, must at once succumb to varying surrounding physical conditions.

Dr. Wallich says that the *onus probandi*, as regards that side of the question against which I contend, does not lie with those who think with him; but "that it is sufficient to show a fair number of cases (as, for instance, in the genus Micrasterias) in which unquestionable interchange of those characters is to be met with, which by Ralfs and others have been seized upon as indicative of a distinct origin." Dr. Wallich will, I hope, excuse me if I still hold that such cases have not yet been shown in the established species of Micrasterias; and that those "interchanges of characters" are founded upon assumption of what it is presumed *might be*, rather than what *is*. I venture to hold still that the interchange of characters between the various species of Micrasterias (I do not, I need hardly say, restrict myself to that genus, but rather mention it as an example) has yet to be demonstrated. I venture likewise as yet to hold that the admission of some forms as species, and others not less well marked as varieties, in this Family (I do not now, of course, refer to Protophyta in general), is, on the whole, altogether arbitrary; and I, for one, cannot refuse to go the length that Nature seems to me here to go, and admit as species all those ultimate forms which seem to be constantly distinct, keeping their ultimate characters to themselves; and each of which, by its own idiosyncracies, one can at a glance perceive is the very same identical plant which, described or undescribed, one encounters more or less rarely or frequently in its own suitable localities.

It will thus be seen, while I venture very deferentially, and with the highest respect, to differ on points in relation to some Protophyta from Dr. Hicks and Dr. Wallich, that there are others on which I cannot but agree as yet with both observers. Nor does it seem to me that the views here put forward conflict with those I ventured to express in my paper read to the Society last Session, on an amœboid state of Stephanosphæra, as regards the perhaps in individual opinion debateable, but as I still hold by no means actually convertible, lower forms of animal and vegetable life. Because some organisms are not always what they seem to be, inasmuch as in the course of their development they may submit themselves to several apparently more or less diversified phases, whilst others (as our Mesotænium and Cylindrocystis) seem to be in this respect more restricted, is not, I think, in either case an argument that Protophyta, or even some Palmellaceæ, may not be subject to specific limits, not to speak of a change from one kingdom to another. With Dr. Hicks I must indeed wholly coincide, that in the study of the Protophyta it is especially desirable that the history of each be, as far as possible, made out, in order to discover the mature forms, and to trace out the seeming changes through which they may pass; but is not this, after all, in other words, to endeavour to find out what *are* the species and their limits, and to learn to discriminate between them? But, assuredly, were all this known, many spurious "species" would have to be erased, at least among certain types. But, whatever phases they may run through, they at least must revert eventually to the parent or type-form; for the same forms turn up and vanish again and again, and season after season, each in its own kind of situation or habitat; and it seems more reasonable that we should suppose—be the intermediate phases what they may—that these would naturally begin and end their cycles in themselves, than that all the many well-defined types and well-marked forms, some more and some less frequently recurring, included under "Palmellaceæ," should need constant recruiting by the transmutation of lichen-gonidia and moss-spores. Perhaps the truth on some of the questions lies in the mean; but, be it as it may, I trust I am not too firmly attached to the views I have tried to express not to relinquish them on good evidence. Meantime, in the words of Dr. Wallich, I at least hold with him, that—"In science, as in governments, truth can never be arrived at on a large scale unless under the pressure of an opposition."

Mr. W. Archer prefaced the foregoing paper by reading an extract from a letter addressed to him by Dr. G. C. Wallich, F. L. S., on the subject of the value of Characters in Protophyta, more especially in Desmidiaceæ. Mr. Archer explained that Dr. Wallich's remarks therein were in reply to observations of his own in a paper read before the Natural History Society of Dublin on the 4th of December, 1863, entitled "Observations on *Micrasterias Mahabuleshwarensis* (Hobson), and on

Docidium pristidæ (Hobson);"* and that Dr. Wallich, having done him the honour to write him a letter containing a summary of his own views on the subject debated in the paper referred to, had requested him to read the same to the Natural History Society. The following is the extract, reference to which is made in the preceding paper:—

"Pray do not for a moment think me inclined to take amiss any differences of opinion on scientific matters. Every one has a right to judge for himself; and in science, as in governments, truth can never be arrived at on a large scale unless under the pressure of an opposition. Besides, the question of specific limits is still in its infancy; and those who cling to permanent specific types are most fully justified in crying out for the amplest proofs before relinquishing their ground. You know of old that I am for no such permanence, but believe that I can trace at every step more and more conclusive evidences that there exists a constant tendency to modification by external influence.

"The point at which you and I diverge is that at which we form our estimates of the value of characters. You maintain that certain characters, because they are more or less constant under the same conditions—that is, in a given locality—afford evidence of persistence of type. On the other hand, I hold they cannot be accepted as evidence of this persistence unless they can be proved to occur under every variety of conditions—that is, in widely remote localities. I speak from experience, when I say that many—very many—of the assumed species of Protophyta and Protozoa are identical—the distinction on which their separation has heretofore been based being entirely the result of the accidental conditions under which they have been reared.

"In the Desmidiaceæ, to which you direct attention more particularly, it appears to me that such differences as the number of indentations, the acuteness or obtuseness of the teeth, the number of spinous processes, and so forth, indicate mere accidental variations, handed down, no doubt, from parent to progeny in the same locality so long as the physical conditions remain the same; but nevertheless not to be regarded as constant, or as impressed on the organisms *ab initio* as an integral feature in their physiological constitution.

"It should be borne in mind that the *onus probandi* does not rest in every example on those who think with me, but that it is quite sufficient that we show a fair number of cases (as, for instance, in the genus Micrasterias), in which unquestionable interchange of those characters is to be met with, which by Ralfs and others have been seized upon as indicative of distinct origin. For such cases prove that the law which it is assumed governs the limits of species is no law, but only a conditional direction, holding good only so long as the surrounding conditions continue the same.

"If, however, the object in view in defining varieties under specific designations is merely to render the identification of similar forms more easy, I have nothing to say against it beyond this, that I should be loth to have to make up the lists even as they stand now, and firmly believe it will be an impossibility for the coming generation of naturalists to do so at all."

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* "Proceedings of the Natural History Society of Dublin," vol. iv., Part 2, p. 79.

XXIII.—On Echinorhynchus porrigens. By John Barker, M.D., F.R.C.S.I., M.R.I.A., F.R.G.S.I., and A. Macalister, L.K.Q.C.P., L.R.C.S.I., F.R.G.S.I.

[Read before the Natural History Society of Dublin, June 2, 1865.]

This animal is so rare—so seldom, too, is its usual host or living residence examined, and so remarkable is it in its form and structure—that no apology is needed for presenting it to your notice, even had it been well described before. The figures of it in the best references are but copies of one another, and unlike our animal in some respects. The Echinorhynchi are acanthocephalic Entozoa; and their name, although it graphically illustrates their chief feature, does not accurately represent the structure. Perhaps Falcatorhynchus would be more appropriate. We must congratulate ourselves that we are not the host of such a monster, with such a formidable proboscis as has been well represented in the diagram by Dr. Macalister. Let us not boast, however; speciesof Echinorhynchus have been found in the Simiadæ, in the *Inuus sylvanus*, and *Midas rosalia;* and we do not know how soon they may be discovered in us in these days of animal progression. The species of Echinorhynchus already known number upwards of a hundred, and are chiefly found in birds and fishes, although they have been recognised in all classes of vertebrate animals. One of the largest, *E. gigas*, inhabits the hog, and sometimes attains the length of a foot. *E. porrigens* is seldom more than six inches long. The specimens on the table are not more than two inches and a half, but these have been much contracted by the spirit of wine in which they were preserved. This species is said to inhabit the Eider Duck (*Anas mollissima*), as well as the *Balænoptera rostrata* (lesser rorqual whale)—a specimen of which has lately undergone a careful examination by Drs. Carte, Macalister, and myself, at the College of Surgeons. John Hunter was, I believe, the first to direct attention to this animal, and subsequent authors have derived their knowledge either from him, or from specimens in the Berlin collection, preserved by Walter, and described by Rudolphi. The Echinorhynchi are vermiform, often curved on themselves, marked with tolerably regular transverse folds, and have a retractile proboscis, armed with recurved hooks. They have neither mouth nor intestinal canal, possess a nervous ganglion, and are of separate sexes. The specimens before us were found in the duodenum of the whale (Walter states that the specimens put up by him were in the jejunum), and their presence was well indicated by large fleshy papillæ, which were found prominent in the mucous membrane of the intestine. The openings of these papillæ were all directed downwards in the course of the intestine, and led to a tubular cavity, situated obliquely between the mucous and muscular coats, in which were contained the head and a considerable part of the entozoon, and also some whitish grumous matter. One of these papillæ is shown opened, with the animal *in situ*, in the specimen before you. The specific name *porrigens* has been given from its capability of being stretched, which, from its wrinkled appearance in the intestine, it well deserves. Sometimes half the length of the entozoon was concealed in the tubular cavity, which was generally an inch long. The *Echinorhynchus porrigens* may be described as consisting of three distinct parts—the head or receptacle, the neck, and elongated body. We shall merely direct your attention this evening to the first, an enlarged diagram of which is before you. It consists of a fleshy body of a double conical form, very wide at its thickest base in proportion to its length; from one of the truncated apices of which protrudes a conical, nearly cylindrical, proboscis, armed with an array of hooks, as you will see in the microscope. We have reckoned about twelve rows, each row consisting of ten or twelve hooks, set obliquely so as to effect a spiral arrangement. They are hollow at their base; and the lower rows are imperfect, or not developed in growth. This formidable proboscis is retractile, and it is generally found in a retracted state. Rudolphi states that he was not able to effect its protrusion; we, however, did not find much difficulty. From its armature and shape one might suppose that in retraction and protrusion it was turned inside out, like the finger of a glove; but we have seen specimens half protruded, and they were not reversed, but drawn directly within a circular muscular collar. This proboscis is retracted by longitudinal bands of muscles situated in the receptacle, which also contains other important organs, which it would be tedious to dwell upon in this abstract. The neck is very thin, and at its commencement smoother than the body, with which it is continuous, without abrupt termination. The body is very deeply wrinkled, these becoming more transverse towards its truncated extremity, where it undergoes a slight constriction.

XXIV.—On the Anatomy of Ascaris (Atractis) dactyluris (Rud.).

By Alexander Macalister, L. R. C. S. I., F. R. G. S. I.

(Plate II.)

[Read before the Natural History Society of Dublin, June 2, 1865.]

As the attention of the members of the Natural History Society of Dublin has been of late directed to the consideration of the group of Entozoa, I think it might not be uninteresting to communicate a few anatomical facts with regard to the structure of a species of intestinal worm, which has lately fallen under my observation. While engaged in examining the anatomy of *Testudo Græca*, I was surprised to find that the alimentary canal in all the individuals which I dissected was filled with worms in large quantities; in fact, that Entozoa constituted more than half of their contents. Of these there were several species; but that which was most numerous was the small, white, usually straight, somewhat shuttle-shaped *Ascaris dactyluris*, first discovered by Bremser, and named by Rudolphi. The species is described by the latter naturalist in his "Synopsis Entozoorum," as "Ascaris dactyluris capite nudo, corpore utrinque æqualiter attenuato; cauda fœminæ longa subulata, maris apice brevis obtuso depresso antequam spicula passim substantia passim egressa vasa in vaginam fimbriatam."* In his subsequent description he refers to it as being found in great abundance; he obtained "multa millia specimina ut maximas fæcum pars iisdem constaret," exactly according with my own experience, as stated above. He likewise describes it as being from two to two and a half lines long, with a three-valved head; a straight narrow œsophagus, which is longer in the male than in the female; a subglobose stomach, and elliptic oblong ova, each with a large and obversely divided nucleus. There are several points of greater or less importance which he has omitted in his description; but, on the whole, these characters are very distinct. Dujardin, in the Appendix to his work on "Intestinal Worms," refers to this animal, and states his opinion that it should be separated from the genus Ascaris, on account of its obscurely bi- or trilobate mouth, and its unequal spicula. He does not enter into any further details respecting its structure, but expresses his regret at not having been able to fulfil his original intention of thoroughly examining its internal organization. A few notices of this species likewise occur in Siebold's "Anatomy of the Invertebrates;" but, with these exceptions, I am not aware of there being any special anatomical description of this creature extant.

The specimens which I have been enabled to examine are whitish in colour, mostly straight, though at times a little curved at the distal extremity, and measuring, as an average, about two lines and three-fifths in length—the range being from one line and a quarter, as a minimum, to five lines as a maximum; the breadth in the centre varies from one-tenth to one quarter of a line, and in some of the largest exceeded that amount. The males (Plate II., Fig. 1), which are very much fewer than the females (at least among those that I examined not one in fifty was a male), are much smaller, and average in length a line and seven-eighths; they are more curved than the latter, and sometimes exhibit a partial dorsal constriction at the junction of the anterior and middle thirds. The females (Plate II., Fig. 2) are usually about two and a half to three lines in length.

The integument is transparent, chitinous, wrinkled transversely, or annulated; but this appearance is not always distinct in recent specimens, or in those kept in aqueous solutions. When, however, they are immersed in any dense fluid, which will cause a rapid exosmosis, the animal becomes slightly shrivelled, and the annulations are then seen with the utmost clearness. When placed in spirits of wine, the integument becomes firmer, and less transparent, and the annulations also seen with considerable distinctness; a few longitudinal striæ are visible on the outer layer, but they do not seem to be regular in their position or arrangement. Towards the tail a considerable number of distinct oblique lines are occasionally seen, radiating from the anus to the dorsal aspect, but they do not seem to be deeper than the superficial tegumentary layer. They commence at the ventral line, and extend symmetrically on either side of it towards the dorsal surface, but stop short of the middle of that aspect. Two lateral lines (Fig. 2, *c*) can be traced with great facility, commencing narrow at the head, widening slightly in the centre, and passing backwards to the posterior extremity, or tail, where they also taper a little, and end near its tip by gradually diminishing; but whether these lines be muscular—as Rudolphi thought—in other species of Ascaris, or vascular—as supposed by Eberth—or nervous, as imagined by Cuvier, Willis, and Cobbold, I could not even conjecture in such a minute species; they appear to me, however, to be most probably extensions of the integument inward, or lateral involutions prolonged into the thin subjacent longitudinal muscular lamina. These lines appear to be made up of longitudinal striæ, with dark granules in their intervals. Anterior and posterior lines are also visible, but less distinct in general than the lateral. The tail is very variable in shape; in the female it sometimes is short, and rapidly acuminated; in other specimens it is long, attenuated, and occasionally even uncinated at its extremity; near the tip small papillary elevations are obvious, and in some individuals give an obscure appearance of serration to its margin (Plate II., Figs. 2, 4, 5). The tail of the male is much shorter, blunter, and more rapidly narrowed to its rounded end, which is more bevelled on its ventral than on its dorsal aspect, to accommodate the masculine organs of reproduction.

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* *Loc. cit.*, pp. 40, 272.

The head presents three tubercles, which are nearly equal in size; but these are not so distinct as they appear to be in other allied species; they exhibit several small irregular granulations on their inner or oral aspect. On using gentle compression, I was able in several individuals to see a fine, slightly curved tube projecting between the three tubercles (Fig. 2, *a*); this, I think, is similar to the tube referred to by Bremser in other species of Ascaris, which he takes to be the true mouth, but which appearance Wedl considers to be due to the protrusion of the everted lining of the cleft proboscis. Through it I was enabled to evacuate, by gentle pressure, currents of granules from the œsophagus.

In a few of my specimens two lateral alæ exist—one on either side of the head; but this appearance seems rather uncommon, as I could only find it in about eight per cent. of the examined specimens (Fig. 3). When present, these wings commenced immediately outside the tubercles by a raised or prominent circular collar, behind which the flat, slightly wrinkled alæ start, and extend backwards and outwards for a short distance, when they rather suddenly contract until their margins become continuous with the wrinkled integument. Though this appears the usual disposition of the wings, it is sometimes departed from, as in one individual I saw the wings extending down the anterior part of the body for a considerable distance, and gradually diminishing, until they were lost about half a line behind the head. In one case, also, the naked subglobose head was united to the trunk by a narrow neck, which was bordered by a slight ala. These variations show, I think, how little these appendages *per se* are to be valued as marks for the distinction of species. I could not associate their presence with any conditions of age or sex; for, though I only saw them in females, they were by no means frequent in that sex, and seemed completely irrespective of youth or maturity.

From the head the œsophagus passes backwards, and is variable in position and length. It is usually curved, with its concavity directed forwards, and it forms about one third of the entire diameter of the animal's body; it is not, however, uniform in calibre; for in some individuals it exhibits slight constrictions, while in others it is dilated into shallow pouches; its cavity seemed to be like that of other Ascarides, rather triquetrous than cylindrical, and its walls were marked with longitudinal striæ; but whether these were due to muscularity or no I could not positively pronounce, though from the thickness of the coats it is most probable that it is a muscular tube. As remarked by Rudolphi, it is much longer and straighter in males than in females, and varies from one-third to one-tenth the length of the entire body, being shortest in those females which were crowded with eggs, and longest in the adult males. Its lower end, after a slight constriction, becomes suddenly dilated into a globose stomach, called by Rudolphi the proventriculus, which is very thick in its coats, and filled with a greenish coloured mass; its cardiac orifice (Fig. 2, *d*) is rather narrow and constricted, while the pyloric aperture is wider, and when compressed seems somewhat valvular—the granular contents passing more freely from the stomach to the intestine than in the contrary direction. In some individuals this cavity was perfectly globular; in others it was slightly conical, and flattened. Its usual shape is that of an oblate spheroid, to the poles of which the œsophagus and intestine are attached. A similar globose cavity in *Ascaris infecta* is described, under the name of gizzard, by Dr. Leidy.* From the inside of the body wall three or four apparently solid curved processes pass to the wall of the stomach, and serve to suspend it in the animal's body cavity. The intestine commences by a clavate dilatation, which gradually narrows, and passes in almost a straight course back to the anus, which is a slit-like orifice, situated a little in front of the tail. Shortly before it reaches this point the gut exhibits a slight enlargement, below which the narrower, sub-cylindrical or pyriform rectum turns off at an obtuse angle, and terminates the canal. Around the constriction, which marks the origin of the rectum, are arranged four small pyriform sacs (Fig. 1 *i*; and 2, *g*)—one in front, one on either side, and one posteriorly—granular in appearance, and having their narrow peduncles, or necks, continuous with a duct (Fig. 2, *i*), which opens into the gut immediately above its termination. This duct was much more distinct in the females. In one specimen a spur (Fig. 2, *h*) was seen distinctly passing backwards to the body wall from the anterior extremity of one of the cæca. Concerning the nature of these bodies we may hazard several conjectures; they might be the representative of such a compound or branched alimentary canal as is found in other Entozoa and in Annelida, or they might be special secreting organs. With regard to the first part of these theories, it is known that intestinal cæca do occur in other species of Entozoa. Mehlis* describes several of these in various species of Ascaris; and Leidy† figures a large cæcum in *Thelastomum appendiculatum*. In these, however, the diverticula arise high in the digestive tract, near the point of junction of the stomach and œsophagus, and open directly below the œsophageal constriction, which is far from being the case in the subject before us. Their granular nature, narrow necks, and constant low position, as well as their number, and the length and distinctions of their ducts, have led me to think that they might, perhaps, be organs of excretion, mayhap the earliest traces of renal organs in the animal kingdom.‡ It may be remembered with regard to this, that the presence of distinct secreting glandular organs in Nematoid Entozoa is no new fact; for Professor Owen has described salivary cæca as existing in *Gnathostoma aculeata*. Other glands have likewise been described, which I will notice more particularly hereafter. From the sides of the intestine below these cæca fine lateral threads pass off, and are lost on the body wall above the anus; these seem to suspend the gut and the cæca, and might be named retinacula.

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* "Smithsonian Contributions," Part 5, p. 43.

The nervous system, if any existed (which we may suppose to be the case from analogy), completely eluded my reach. There are, as I have before stated, dorso-ventral lines, and in some individuals the ventral was much the larger and more distinct. It may be nervous in its nature, but presented no distinct character by which I could recognise it as such.

On the ventral aspect of both sexes, corresponding to a concave and well-marked sinuosity or depression of the superficial abdominal line, a very small bilobate aperture was visible on the body wall opposite, or a little above the level of the upper dilated end of the intestine; in one or two, however, it was much below this point. From this a small tube (Fig. 1, *c;* and 2, *m*) passes for a very short distance inwards, and then gives off four small prolongations, two of which pass forwards, and are lost in the anterior part of the lateral lines, while the other pair pass back into the posterior portion of the same lines, where they expand into very small dilatations (Figs. 7 and 8), beyond which they are not traceable. It was with very considerable interest that I detected this structure, which is similar to that described and figured in the Appendix to

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* "Isis," for 1831, p. 91.

† "Smithsonian Contrib.," Part 5, p. 49, Plate VII.

‡ "Annals of Natural History," July, 1865.

Bagge's "Dissertatio de Evolutione *Strongylus auricularis*," and which has been traced by Diesing in other Nematodes. Mehlis* describes a similar organ as existing in *Strongylus hypostoma*, but imagined he saw it passing as far forwards as the mouth, in which he thought that it terminated; but this error was corrected by Von Siebold; and in many of my specimens the character of the external foramen is seen with extreme clearness. This undoubtedly is a glandular organ, but of what nature it is hard to say. Mehlis† has put forward a not improbable hypothesis regarding its use, and imagines that it pours out an irritating secretion, which stimulates the wall of the intestine of the host, and so causes it to pour out an increased amount of pabulum for the animal's wants: such may be the case, but we have no evidence on the subject. It might perhaps be a rudimentary water-vascular apparatus.

Enveloping in its convolutions the intestinal canal in the female, a tortuous elongated ovarian tube can be traced (Fig. 2, *b*): usually single, though in three of my specimens I found it to be double. It commences by a narrow, but not very sharp-pointed, extremity, which is apparently attached slightly to the deep surface of the body wall, near the lower end of the œsophagus; from this point it courses tortuously, measuring when extended twice or three times the length of the entire body of the animal. At its commencement it contains a finely granular, almost homogeneous mass, which shortly becomes consolidated into oval vitelline masses, which soon (Fig. 2, *k*), at a small and very imperfectly marked dilatation in the tube, become perfect ova of a narrow elliptic shape, composed of a dark granular, at first obscurely divided vitellus, which occupies one half of the bulk of each ovum, and is surrounded by a transparent albuminous fluid, enclosed in a hard casing or shell. These ova are arranged in a single row in the lower or uterine portion of the oviduct; and occasionally from a rupture of this tube they may be seen floating free in the body cavity of the parent. The perfect ova are not so numerous as they are described to be in other species of Ascaris. I have found them to range between twelve and fifty-five in number. The uterine tube, or oviduct, terminates at a small, round, oblique opening on the ventral aspect of the animal, and usually at a point midway between the stomach and the anus (Fig. 2, *l*). In case the oviducts be double, they coalesce shortly before they arrive at the vulva. Siebold refers to this opening as being a transverse slit, with swollen margins; but it certainly seemed to me to be roundish (Fig. 6), and bordered by a slightly prominent lip or margin, surrounded by a sulcus. The coats of the duct thicken, and the cavity contracts immediately before it ends at this aperture. When some of these females were left immersed in water for a week, the ova commenced to become developed. At first the eggs were filled with finely granular, irregularly divided vitellus, which soon regularly segmented. Its first stages of segmentation escaped my observation; and many ova presented six, nine, or more globules of the parted yolk when first I examined them (Figs. 9, 10, 11). Soon the mass became finely granular, and assumed an elliptical shape, which in some became curved or arcuated. The two extremities then begin to be differentiated, and from the posterior end a lateral turn or projection extends, at first short, but soon considerably elongating, until it becomes remarkably like the tail of the adult, twisted to one side (Fig. 12). The anterior end becomes blunt, and somewhat flattened, and no granules appear in it. At this stage in some of the more perfect a moniliform thread appears to pass down the centre of the body from the mouth to the root of the tail projection, forming the primitive trace of the alimentary canal (Figs. 13 and 14). I was not able to observe the development of the reproductory apparatus; but it is probable that it does not appear until the young animal has become liberated from its shell. All the changes which I have noted took place inside the oviduct of the mother; but I also observed ova floating in the surrounding fluid in similar conditions of development.

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* *Loc. cit.*, p. 49.

† "Isis," 1831, p. 81.

The male sexual organs are made up of—first, a testis—tubular, and elongated, but not so long as the ovary; this begins small, and rapidly thickens, until it rivals the intestine in size (Fig. 1, *d*). This is at first filled with an indistinct granular material, but afterwards contains more perfectly elaborated spermatic fluid. These tubes are not easily unravelled; and in some males (probably those which are immature) the whole glandular mass appears as though it were a lobulated indivisible structure. Near the posterior extremity of the body the testicular tube ends in a large, dark, rough, bilobed seminal vesicle (Fig. 1, *e*), which lies on the ventral surface of the intestine, and sends off below a narrow duct (Fig. 1, *g*) to the root of the intromittent organ. In front of the blunt bevelled tail projects the spicula—a slightly curved body, with a pointed pen-shaped extremity; half of it is included in a canal in the animal's body, from which it passes by a small opening, whose smooth projecting margins overlap its sides for a short distance (Fig. 1, *h*).

A little in front, and to the side of the large spicula, a smaller one is seen, much more acute, and communicating with the spermatic vesicle by a small canal. This second smaller organ did not escape the attention of Dujardin; and it was noticed by that naturalist as a character marked enough to separate this species from Ascaris, and to elevate it into a genus by itself. To this distinction I think we will be able to confirm its claim after our careful examination—first, on account of its unequal spicula; secondly, from its rudimentary cæcal secreting appendages; thirdly, from the comparative indistinctness of its oral tubercles; and so, following the great French helminthologist, I think we are justified in naming it *Atractis dactyluris*.

I cannot close these remarks without taking the opportunity of recognising my obligations to Dr. John Barker for his invaluable assistance in the course of my investigations, in verifying from independent observations almost all the results which I have tabulated in this paper.

XXV.—NOTES ON THE FOLIATION IN THE GNEISS AND SCHIST OF YAR-CONNAUGHT. By G. HENRY KINAHAN, Senior Geologist of the Geological Survey of Ireland.

(Plate IV.)

[Read before the Royal Geological Society of Ireland, January 10, 1866.]

THE foliation in the metamorphic rocks of Yar-Connaught seems generally to follow some variety of lamination, and rarely the cleavage planes; I shall, therefore, first copy from my note book the places in which it may follow the cleavage.

A little north of Lough Seecon (*Galway*, $\frac{54}{4}$),[*] "the foliation is slightly oblique to the bedding, and seems to follow the cleavage planes."

In the stream, a few yards west of Knockbane gate (*Galway*, $\frac{68}{3}$), "the foliation in a bed of schist is slightly oblique to the bedding, and seems to follow the cleavage planes."

Keerauntoole (*Galway*, $\frac{53}{2}$), about half a mile due north of Lough Adrehid, "the foliation generally follows the lamination; but in one bed of schist it seems to follow the cleavage planes."

Curraduff West (*Galway*, $\frac{39}{4}$), "in the stream south of Captain Tracy's Lodge, in a bed about five feet thick, there is a foliation oblique to the bedding; and, as the rock is more a schist than a gneiss, perhaps it may be the cleavage planes that the foliation follows."

The foregoing are the only instances which I find in my note book; and though in each of these places I believe that the foliation coincides with the cleavage, yet in no place would I be quite certain, as it might be the oblique lamination that it followed.

Oblique lamination is usually common in grits and sandstones, and in the gneiss of Yar-Connaught oblique foliation is common. I shall mention a few instances.

In the townland of Derryeighter (*Galway*, $\frac{53}{4}$), a little south of Knockwaumnamoe, the foliation in the gneiss is oblique; a sketch of this will be found at Plate IV., Fig. 1. In the townland of Doon (*Galway*, $\frac{67}{4}$) part of six beds were sketched, in three of which the foliation was oblique (see Fig. 3). The highest bed in this sketch is meant to represent a Porphyritic Granite. Fig. 4 was taken near this place; it shows doubly oblique foliation in one bed.

Fig. 5 is a diagrammatic section of a cliff a little east of Letter Lodge (*Galway*, $\frac{67}{4}$); the general rock thereabouts is a foliated Granitic Porphyry; but in this place there is a vein of green gneiss, consisting of five beds, the foliation in the first and fourth of these, counting from the right hand (east side), is parallel with the foliation in the granite, while in the other three it is more or less oblique.

I find that I noted, "in the gneiss the foliation generally followed either the lamination or oblique lamination;" but to this there are exceptions. At the south-east corner of Curraghduff East (*Galway*, $\frac{40}{3}$) a very quartzose gneiss was observed, full of small almond-shaped particles of quartz, round which the foliations curled. This I have tried to represent in Fig. No. 9. In some places there is also a nodular foliation in the gneiss; but this is not very common. Good examples of it, however, will be found among the rocks that appear in the neighbourhood of the town of Galway, more especially in the low swampy tract of ground through which the railway runs S. S. W. of Lough Atalia. There the nodules are generally whitish or reddish (*micaceous gneiss*), while the rest of the rocks are blackish or greenish (*hornblendic gneiss*), which gives them a very marked appearance.

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[*] This refers to the quarters into which each Sheet of the Ordnance Maps is divided by the officers of the Geological Survey.

In shales there are a variety of structures; a very common occurrence is to find a "curled" or spheroidal structure; numerous sketches of which will be found in the "Memoirs of the Geological Survey," more especially those written by Mr. Du Noyer;* and in the schist we find a spheroidal foliation. Good examples of this were noted in the townlands of Leam West and Bunnakill (*Galway*, $\frac{53}{1}$), a little east and north-east of Lough Aphreaghaun. In that neighbourhood this kind of foliation is extremely well developed, but it will also be seen in other places, having been observed in the hills west of Glan (*Galway*, 39 and 40),‡ on the hills west of Ross Lake more especially about Knockseefin (*Galway*, 67), at Leam (*Galway* 53), which lies west of Oughterard, &c.

Another structure that occurs in shales, and to which I drew the attention of the Society some time since,§ is the crumpled or wavy lamination. This also has its representative among the varieties of foliation; an example, of which Fig. 6 is a sketch, was observed a little north of Lough Seecon (*Galway*, $\frac{54}{4}$), in a thin bed of mica schist, between two beds of gneiss. An excellent illustration of it was seen in the townland of Lettercraff (*Galway* $\frac{54}{1}$). Fig. 7 is a rude sketch of it; but it only gives a faint idea of what it really is, as the crumpling is so intricate that it would be impossible to copy it, except by a photograph. Another variety of curled foliation is when nodules appear in the mass round which the foliation curls. This, as before mentioned, is found in the gneiss, as well as the schist. Fig. 2 represents an example which was observed in the townland of Killaguile (*Galway*, $\frac{67}{2}$). This is a most instructive case; for, besides the foliation of the schist curling round the nodules of gneiss, the latter are found to be obliquely foliated. A very common case is, when the nodules are of quartz; Fig. 8 is a sketch of two quartz nodules in curled foliation that were remarked in the townland of Gorteenwalla (*Galway*, $\frac{40}{3}$). The foregoing are cases in which the foliation follows peculiar varieties of lamination. The lamination in rocks is usually parallel to the planes of stratification, so in Yar-Connaught the foliation is generally parallel to the same; it is, therefore, unnecessary for examples of this kind to specify any particular locality.

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* "Memoirs of the Geological Survey of Ireland." Ex. Sheet 137, p. 23; Ex., 162, p. 16; Ex., 175, p. 27, &c.

† It also occurs in the gneiss, but not so frequently.

‡ This name is not usually inserted in the Maps; but the tract of low country west of Lough Corrib and north-west of Oughterard is always called by that name.

§ See "Dublin Quarterly Journal of Science," vol. iv., p. 112.

I have now mentioned six varieties of foliation, one of which may follow the cleavage planes, while the five others follow the lamination; the parallel foliation being caused by the parallel lamination; the oblique, by the oblique lamination; the spheroidal, by the spheroidal lamination; the crumpled, or wavy, by the crumpled lamination; and the curled, by the lamination that is curled round the nodules. These, at least in this district, seem to be the only structures that cause it; for, though it is easy to tell a rock that was originally jointed by the "jumped" appearance of the foliation, yet, if the latter is examined, it will be found to follow one of the six structures just now enumerated.

I would venture to suggest that any one interested in foliation could learn much by carefully examining Yar-Connaught; as, besides the foliation that I have just mentioned in the gneiss and schist, he would find a curious structure, like foliation, in the intrusive granite, and peculiar foliations in the metamorphic trap masses and dykes, and in the metamorphic conglomerates and limestones, and also many interesting cases where the rock masses had originally been cut up by small faults, or where pieces of hard beds had been squeezed into the adjoining soft ones.*

None of these latter have I entered into, as it would make my paper too long, besides that all of them, excepting the limestone, are in a manner foreign to my subject.†

XXVI.—ON A TRAP ROCK AT BRAY HEAD, COUNTY OF WICKLOW. By W. H. STACPOOLE WESTROPP, M. R. I. A.

[Read before the Royal Geological Society of Ireland, April 12, 1865.]

BRAY HEAD is composed of Cambrian grits, slates, and quartz-rocks, which have a general dip of from 40° to 90° towards N. 12° W.

On the top of the hill several masses of amorphous quartz-rock occur, of which only two come down to the sea shore—the northern or Brandy Hole one and the great southern or Windgates quartz-rock, which form such prominent features in the scenery of the Head, their yellow colour and rugged form contrasting finely with the sombre tints and smoother outline of the grits and slates.

Some time ago, Professors Harkness and King discovered a bed of greenstone about one hundred yards south of the Windgates quartz-rock, by the side of an old road, running a little above the present walk, which skirts the eastern side of the hill;* these gentlemen told Mr. Jukes of its occurrence there; and during Easter week last year (1864), Mr. Jukes showed it to me when he was giving a field lecture to his geological class; he said he had traced it up the hill, but that no one had tried to find its extension down to the sea shore.

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* Examples of these squeezed beds in unaltered rocks will be found in the "Memoirs of the Geological Survey of Ireland," Ex. of Sheet 128, p. 18, and Ex. of Sheets 115 and 116, p. 25.

† I have not included the limestone in these notes, although it seems to follow similar rules to those of the gneiss and schist, as there is something about it which as yet I do not quite understand.

I spent some days last summer in examining it, and I hope that a brief description of the facts which were observed will have sufficient interest to excuse my bringing them under the notice of the Royal Geological Society of Ireland.

From the place where the trap can be first seen towards the top of the hill, down to the spot where Professors Harkness and King noticed it by the old roadside, it appears to occur in one bed about five feet thick, regularly interstratified with the grits and slates. In the cliff between the walk and the railway it begins to show a tendency to split up; for a second bed, only an inch or two thick, appears, which runs parallel to the main bed, and is separated from it by grits, &c.

The trap disappears under the railway embankment, and would not be again seen but for a fault having an upthrow to N. N. W. of about 150 feet; this brings up the trap about sixty yards to the north, where it may be seen on both sides of the railway, near the south entrance to the tunnel, whence it can be traced down to the sea shore. Below the railway it becomes split up into several beds; and on the sea shore I counted as many as seven, varying in thickness from two inches to one foot; there are also some curious fine veins 0·25 to 0·5 of an inch thick.

The rock is greenstone, having different textures in different parts; up the hill, where it occurs in one bed, it is a hard, finely crystalline rock, of a dark greyish green colour, and very durable, for it is scarcely at all affected by weathering; but where it becomes split up into a number of beds, it is a rotten brownish-green rock, with numerous black specks of a mineral, which probably is hornblende; some of these thin beds have quite the look of an ash.

The trap is so regularly interstratified with the sedimentary rocks, that at first sight it might be supposed to be contemporaneous; however, I believe it to be intrusive; for the fine veins, before alluded to, may be seen entering into the adjacent beds of slate—some dying away, while others cut across the laminæ of the slate in a manner that I cannot think an ash would behave; nevertheless, any one examining a hand specimen of one of these veins would be inclined to call it an ash.

I think it not improbable that the more crystalline part, up the hill, may be nearer to the focus from which the flow originally proceeded than are the thin beds on the sea shore.

In conclusion, I beg to observe that, while there is such a profusion of igneous rocks associated with the Lower Silurian deposits of Wicklow, it is rather remarkable that one small greenstone dyke at Greystones, and the trap I have just described, are the only ones which have yet been found in the Cambrian rocks of that county.*

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* Fossil collectors may be glad to know that between the quartz-rock and the trap there is a bed of fine purple slate, full of *Oldhamia radiata;* I also detected in it the rarer form *O. antiqua*, and marks like those which have received the name of *Arenicolites.*

XXVII.—ON THE OCCURRENCE OF KJÖKKENMÖDDINGS IN THE COUNTY OF DONEGAL. By WILLIAM HARTE, Esq., C. E., County Surveyor of Donegal.

[Read before the Royal Geological Society of Ireland, February 7, 1866.]

THE great interest which attaches to the subject of the shell mounds of Denmark, Scotland, &c., must make the record of the occurrence of similar formations in Ireland a matter of some importance, and it scarcely needs apology from me for bringing it under the notice of the Royal Geological Society of Ireland—important even if it should only direct the attention of those to the subject who have an opportunity of observing perhaps still more interesting cases in other localities, but which have hitherto escaped observation; for I believe that these shell mounds have rarely, if ever, been met with in this country before. It would be out of place for me, before this Society, to enter into an explanation as to what Kjökkenmöddings are; but, as this paper may answer to a certain extent as an advertisement to some who, though they may meet with such, may not be so well informed as geologists are, I may say something by way of general description, in the hope that before, as I have reason to fear is too often done, these valuable records of the past are destroyed by manuring land with them, we may be afforded an opportunity at least of examining, if not of preserving them. Briefly, then, I may mention that along the coast of Denmark particularly, and later still in Scotland, have been found large heaps of shells, which have been proved beyond all doubt to be the refuse heaps of the earliest human inhabitants of those countries, and among them the remains of animals and plants, the study of which has thrown some light on the history of the Fauna and Flora of those times, as well as upon that of the antiquity of man himself, for among them his works, implements, &c., have been found also; and here we are taken back to that neutral ground where the geologist and the archæologist meet.

I now proceed to describe the instances I have to bring before you. While investigating the Drift in the neighbourhood of the Island of

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* However, in the county of Dublin, at the Hill of Howth, there are numerous trap rocks. I believe them to be, without exception, intrusive. From these data we may safely infer that during the period when the sand and mud were being deposited, which now form the Cambrian rocks of the east of Ireland, there was no volcanic action going on, and that many, if not all, of these trap dykes were intruded during the succeeding geological period; for in the Lower Silurian rocks of the county of Dublin, at Portrane, Lambay, &c., and in rocks of a similar age throughout the county of Wicklow, *contemporaneous* traps and ashes are extremely abundant.

Inch, which forms part of the eastern side of Lough Swilly, in the barony of West Innishowen, my attention was attracted by a bed, or rather the remains of a bed, of oyster and other shells, lying just upon the slope of the "boulder clay," through which the Derry and Buncrana Railway is cut, immediately at the Inch-road Station, and a moment's examination sufficed to convince me that I had come upon a true Kjökkenmödding. While ascertaining the height of the bed above high-water mark, an intelligent countryman, who had joined me, undertook to enlighten my ignorance, and remarked—"Sure the sea was never up there at all, but in ould times the people used to gather here to eat oysters," and, he added, confidentially, and with a knowing smile (evidently anxious that I should have a good opinion of the wisdom of his ancestors in the face of so much cold oysters) "to drink whishkey." I confess I was at first staggered by this; for, strange to say, at this day a custom prevails in the Bay of Donegal, the Carboniferous rocks of which are covered by delicious mussels (*Mytilus edulis*), where the mountaineers from the Barnesmore Mountains, with their families, about Easter, come down in their carts, turn their horses adrift, and squat for days (and nights, too), and roast and feed upon these shellfish. It is a sort of holiday proceeding, and if any one wants to see very recent Kjökkenmöddings, he has only to visit St. Ernan's shore, near Donegal, and he will find them there—shells, fireplaces, whiskey, and all! No doubt, it was this association of ideas that made my informant come to the conclusion he did. Immediately I set to hunt for flint implements, but none were to be got. I heard, however, that there was a similar bed about a mile away, and I started for it. Here I was more successful, and found several.

I call the first bed No. 1, this other No. 3; and on my way back I found the remains of a third lying between the two—this I call No. 2. Those three shell mounds I have marked upon the sheet No. 11 of that beautiful production of the Ordnance Department, the One-inch Map of Ireland; and you will perceive that the Island of Inch stands in the mouth, as it were, of the cross valley which runs from Lough Foyle to Lough Swilly; thus forming two channels—the one to the south being called the "Farland," and that to the north the "Fahan" Channel. Up both these channels the sea flowed round the island, and some distance inland, until Mr. M'Cormick, the late Member for Derry, made an embankment across each, thus reclaiming large tracts over which the sea flowed to the N. E. and S. E. of Inch. No. 1 is at the end of the embankment, near the railway station; No. 2 is at the opposite end, on Inch Island; No. 3 is at the north end (on Inch) of the Farland embankment. I have no doubt but there must have been a corresponding fishing station at the south end of this embankment; but, if so, it has gone bodily to make the railway and the embankment.

It will be seen, on reference to the Ordnance Sheet, that there is another "reclamation" of an arm of this estuary at a place south of the Farland, called "Blanket Nook;" and, judging by analogy that there should be another shell mound there, I visited it. I had no difficulty in finding, close to the embankment, the remains of a far larger bed than any of the others. It has, however, been greatly disturbed, but the situation and character of the shells were the same (the oysters, however, were not so large) as the others. Still, in the short visit which I was able to pay it, I myself found no flint flakes, or other implements. I believe a good deal of the shells have been burned for lime. The whole bed has been dug over, and the sea seems to have encroached upon it, as it is much more exposed than the others. I have marked it No. 4, and have since received some flint flakes and split bones, which were found there by my assistant. Nos. 1, 2, and 3, are all situated close to the shore, and at the same level, twelve to fourteen feet from high water, a little sheltered from the west, and high enough, no more, to be out of the wash of the waves. The greater part of No. 1 has been levelled down, and removed, and but little of it remains. It is from eighteen inches to two feet thick, evidently on the edge of the original mound. No. 2 is nearly all away, removed for filling or manure. No. 3 is likewise much destroyed, but what is left of it is in better preservation than the others. It is from two to three feet thick, and a great deal of what has been removed has been spread over the land immediately adjoining it.* I exhibit several flint flakes, and one axe, with the number of the mound on each from which I obtained them.

The following description, except where special mention is made, applies equally to 1 and 2—these mounds show good sections, being cut right through. The shells are a good deal compressed, free (except where the surface has been dug a little into the shell bed) from any admixture of sand, gravel, or loam. The shells are for the greater part those of full grown Mollusca, the others being exceptions. Scarcely any of the Turritellæ or small shells are to be met with, which are so characteristic of raised beaches. The different kinds are more or less grouped together, too; they are not rolled, and have evidently never been disturbed since they were first placed there. In No. 3 stones were found bearing the marks of fire, and one lump of cemented oyster shells, too hard to break except with a crowbar, which had been, I think, so made by the action of fire and pressure, for in it were embedded ashes or charcoal; I exhibit specimens of both. No pottery has been found, and only one entire bone—a vertebra—which my friend Dr. Carte has been so kind as to identify for me as probably that of a red deer (*Cervus elaphus*), and I am also indebted to him for the revision of the following list of the species found:—

INVERTEBRATA.

MOLLUSCA.

Gasteropoda.—*Buccinum undatum*, common; *Litorina litorea*, common; *Litorina litoralis*, very plenty; *Trochus magus*, very plenty, and all large; *Nassa reticulata,* uncommon; *Natica,* uncommon; *Purpura lapillus,* uncommon; *Patella vulgata,* not very common.

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* It is hard to say what the length of those heaps was; No. 1 appears to have been about eighty yards long, No. 4 much longer.

CONCHIFERA.—*Ostrea edulis,* very common, and forms the principal part; *Pecten maximus,* uncommon; *Pecten varius,* rather common; *Mactra truncata; Mytilus edulis,* not common; *Cardium edule,* not common; *Tapes decussata,* common; *Tapes pullastra,* common; *Mactra elliptica,* rare.

Those Molluscs live on this shore now.

VERTEBRATA.

AVES.

A wing bone of a goose and some fragments of ribs.

MAMMALIA.

One lumbar vertebra of a ruminant, probably *Cervus elaphus,* and a number of bones of ruminants, split for the extraction of the marrow.

The oysters, the shells of which are before you, are far larger than the oysters of the same locality at present. Inch was celebrated for its oysters a few years ago; that is, it produced quantities of a very small oyster, which sold at about fivepence a hundred—the produce of a hundred not at all compensating the trouble of opening them. They are the dwindled descendants of the fossils before you; and probably this degeneracy is due to the greater quantity of fresh water coming down in times of floods into the Lough, owing to drainage, &c. At present the almost only use made of these oysters is that they are packed up in barrels as young oysters, and, in the teeth of all "artificial selection," exported to England as seed oysters to stock new beds! It is scarcely necessary for me to point your attention to the implements before you, but you will see that they are highly characteristic of the Danish Kjökkenmöddings. They are rude in the extreme, and belong to the class of Stone implements called "flint flakes"—those of the earliest Stone age, and without a trace of that polish or beautiful finish which I have seen in the private collections of more than one gentleman in this country, illustrating the later Stone period. The stone axe alone, from No. 3, made of a brownish quartz, is perhaps some little exception. Some few of the stones are doubtful-looking, but they seem to have been used for some purpose.

It has been remarked that in loughs those shell mounds are better protected that on the sea coast. Here is an instance of it, and I hope one that will induce others to look out for them; and, as there ought to be many more in Lough Swilly, and I have no doubt in Lough Foyle too, I shall be most happy to explore them for any one who will kindly direct my attention to what appears to be such. These shell mounds are interesting from another point of view, too. There is an old tradition that the country in which they occur was an island. It must have been, however, about the same time, three islands—viz., Inch, then the country north of that as far as the valley from Malin to Culdaff; and the third, from that valley to the sea. Was it so within the human period? Certainly not at the time of these shell mounds. Those who made them carried their food sufficiently high up to get out of the reach of the waves; so that the land has not been upraised since that, or these mounds would be higher up; neither has it been depressed, for, as I have said, there is not the slightest trace, but quite the contrary, of the sea ever having reached them, which it would do (at least its waves would) if they were lowered ever so little. General Colby, in his Ordnance Memoirs of Derry, explains the etymology of Innishowen as being Innis Eogan, or the "Island of Eogan," as it is nearly insulated by the two arms of the sea, called Lough Foyle and Lough Swilly. This scarcely goes far enough. An elevation of the sea, little more (about twenty feet) than would submerge these Kjökkenmöddings, would render it a complete island, or, as I said, three islands; for it would flow up the valley to Lough Foyle, along the course of the Derry and Lough Swilly Railway, and, what is more important, it would also fulfil the other tradition which also exists of the passage of the sea from Malin to Culdaff through the parallel valley to the north. But I think I can see another solution of the question; for, if a man was an inhabitant of this country when its Drift was formed, then undoubtedly he was a witness of the existence of these islands; but, even if not so, the wild men who made these shell mounds, as they stood there, before the vegetable soil was formed which now covers their work, and the Drift alike, must have observed the fact that the sea had but lately, comparatively, left the valley dry; they had fresh before them the records of the Glacial epoch, which we have but to lift the mere sod which covers the rock even now to see too; and they doubtless named their fishing grounds as islands, one of which, in ages after, became the "Island of Eogan."

Note.—Since writing the foregoing, I have found also two other stations, a little to the west of the old castle upon Inch Island. Here several fine flakes were found, and one good "core," showing that raw material was imported (as Professor Jukes has observed) from Antrim, and manufactured upon the spot. Some other points of interest were observed also, of which I reserve notice for the present.

XXVIII.—CRUMPLED GRANITE BEDS IN THE COUNTY OF DONEGAL.

By WILLIAM HARTE, C. E.

[Read before the Royal Geological Society of Ireland, March 8, 1865.]

THE Granite of Donegal has been well described as being decidedly gneissose in its character ("Rep. Com. B. A.," 1863, p. 51), and the evidences of this are somewhat varied.

In the Gweebarra Valley, for instance, the granite rocks are very massive, and present a little of the appearance of ordinary gneiss; for they are traversed by bands of black mica (or more micaceous granite than the rest), which give at first an appearance of stratification, which, however, imparts little or no schistose structure to the rock.

Again, we find, inclosed in the granite patches of schists at different places, and into which the granite often seems to pass.

To a third, but distinct class of structure, I have now to direct your attention, which seems to me to have an important bearing upon the question as to the origin of granite, at least of that of Donegal.

We find sometimes, alongside the amorphous and highly crystalline granite, thin slabs of the same texture, and, though the structure is gneissose-looking, quite devoid of lamination.

Nowhere is this more observable than near Dungloe, and at about half a mile from that village, on the road to Maghery, the granite, which lies between the road and the shore, is thinly stratified vertically; and, common as is the contortion, or crumpling, in the case of the gneiss imbedded in the granite, in no instance until here have I met with a similar phenomenon as regards the so-called granite proper.

Those beds vary from one inch upwards in thickness, and may be traced for a considerable width and distance along the shore.

At the point I have described they are intersected by a line of crumpling, nearly at right angles to the beds, which bear 15° E. of N. (Mag.); and, so far as texture goes, there is nothing to indicate whether this plane is that of original bedding (lamination), or not—for the whole is essentially granite in its texture—but its coincidence with that of the ordinary strike of the beds of the primary rocks marks it as such.

These beds "thin out" in a remarkable manner, and in many respects in the same manner as in the ordinary metamorphic and sedimentary rocks.

I lay before you specimens of those crumpled beds, where they "thin out," with "slickenside" surfaces; and also a specimen of the straight beds, showing how the rock is traversed by so many joints, that any attempt to quarry it reduces it nearly to the state of road metal.

This "joint" structure of the Donegal granite has been described by the Rev. Professor Haughton in his "Experimental Researches on the Granite of Ireland," in vol. xviii., p. 403, of the "Journal of the Geological Society of London," where he calls these planes of bedding "cleavage planes," and the intersecting ones "joint planes."

I find the bearings of them to be as follows:—

Cleavage, ...	15° E. of N. Mag.
Joints, ...	85° E. of N. ,,
Ditto, ...	55° E. of S. ,,

Here I may observe, that in the case of this granite much care is required in observation, as these "joint planes" are sometimes so finely developed, that they are scarcely to be distinguished from those of "cleavage," giving, as it were, planes of false stratification; but in these contorted portions of this granite the regularity of the joints is lost, and they are completely confused.

Here, then, we have the same features of plasticity, &c., characterizing the highly crystalline granite that we find in the acknowledged metamorphic rocks, but when the metamorphic action was more powerful, and such as was sufficient to destroy the ordinary appearance of lamination, if it existed; and, as I am not aware of any similar case having been observed before, it struck me as being worth placing upon record.

XXIX.—Notes on Part of the Leinster Coal Field, with a Record of some Fossils found therein. By William Bookey Brownrigg.

[Read before the Royal Geological Society of Ireland, June 14, 1865.]

The following notes relate to the Jarrow colliery, situated under the townland of Cloneen, otherwise Bawn-Jarrow, in the county of Kilkenny. Before proceeding further, I would wish to acknowledge the obligations which I am under to Mr. S. Bradley, the owner of the mines; and to Mr. K. Dobbs and his son, of Coolbawn. It is owing to their courtesy and love of science that I have the honour to lay before the Society, this evening, a collection of fossils; which I believe will be regarded as one of the most remarkable series of specimens which have ever been obtained at one time.

The date of the first boring of the Jarrow mine, in which I discovered these fossils, was 1812. It was first worked successfully in 1827, and continued open till 1832, after which date it was not worked till 1853, when it came into the possession of Mr. Bradley, the present owner.

So far as I have been able to learn, no fossils, of any note, have ever been found in this or any of the adjoining mines previous to those which I have lately discovered. The principal seam in it is known as the "four-feet coal," and it is the hardest and least stratified in the district.

The part of this mine which is worked presents the following section, reading it from the ceiling downwards to the coal-seat:—

The roof is formed of five feet of "clay slate," immediately under which there occurs a seam of "inferior coal," about three inches in thickness. Next beneath this lies the best seam of coal, known as the "stone coal," which is about three feet in thickness, and rests on a worse description of "foliated coal," about one foot thick. Underlying all these there exists a layer of slaty coal, nine inches in thickness, and known to miners as the "wire sole." Immediately under the wire sole there is a four-inch coal, resting upon what the miners call a "white slate," which latter is two feet in thickness, and is superposed to a bed of "culmy coal," six inches in thickness, resting directly upon the coal seat.

Nearly all the fossil genera of which I have obtained specimens in this mine are confined each of them principally to a particular stratum. I may also mention that the four-feet seam is not to be met with in any of the adjoining mines; which I think may probably be explained by the supposition that it forms part of what was once the uppermost stratum, or innermost saucer-like bed of the basin in which these deposits were formed.

I have now the honour to lay before you specimens of the fossils which I have obtained. I believe that I shall be found to be correct, when I express it as my opinion that I lay before the Society this evening, amongst other specimens, at least six, if not seven, perfectly new genera of reptiles.

I have brought these remarkable fossils before you perhaps somewhat prematurely, and while the specimens which I have obtained are more or less imperfect, principally with the view of securing the priority to the discovery, and the priority of publishing their notice to our "Journal."

I do not attempt to enter this evening into what would necessarily be an imperfect description of them, in the present stage of the inquiry: as I do not believe that it would be for the interest of science that I should do so until I shall have obtained more perfect specimens. However, I hope to be in a position to describe them at no distant day; and I desire to take this opportunity of thanking our Council for most liberally promising to illustrate such description with four Plates, in our "Journal." There is one fossil in particular which I would wish more particularly to notice, on account of its very remarkable hourglass shaped caudal vertebræ and processes, and which I propose to call "Wandesfordii," after Mr. Wandesforde, the lord of the soil.

In conclusion, I feel happy in having been so fortunate as to rescue even those few specimens now before you from the work of geological destruction which is daily proceeding in all mines and quarries throughout the world. As each part of any mine is abandoned, being commercially exhausted—as each pillar is fired, each portion of the roof allowed to fall in—there is lost for ever to Palæontology an accumulation of records, whose destruction is hardly less sad to science to contemplate than the burning of the Alexandrian Library of old was to knowledge. It therefore the more behoves all "brethren of the hammer" to be constantly up and doing. This work of destruction is taking place in every part of the world every day, and therefore they should be on the look out every hour, in whatever part of it they may be living.

Who can tell what vexed problems of the geologist may have their solutions lost for ever to science by each day's recurring operations in mine or quarry?

XXX.—On Submarine Earthquakes and Volcanos. By Dr. J. M. Barry, L. K. & Q. C. P., L. R. C. S. I., M. R. D. S., M. R. Z. S., &c., &c.

[Read before the Royal Dublin Society, April 16, 1866.]

During the month of November, 1865, I experienced in the South Pacific Ocean some of the phenomena attending submarine volcanic action. This circumstance, together with subsequent opportunities of collecting information on the subject of marine earthquakes, has suggested my bringing this paper before the Society this evening.

I have succeeded in discovering the records (which I have every reason to believe authentic) of more than thirty instances of volcanic disturbance in the Atlantic Ocean, between the years 1740 and 1860. A short abstract of some of the most important I beg leave in the first instance to draw your attention to.

There is a space on either side of the Equator, between 7° N. and 3° S. Latitude, and 16° to 29° of West Longitude—an area measuring some 600 by 800 miles—which may be deemed one of the great submarine centres of volcanic action; within the limits of this space *smoke*, *steam*, and ashes have been seen to issue; vessels traversing it have experienced shocks, more or less violent, and in some instances have struck on unknown rocks, subsequently not to be found.

In the year 1813 the ship "Warley" passed over a shoal in Lat. 5° 4′ N., and Long. 24° 25′ W. In the year 1796 a French authority reported a shoal in 4° N. 19° W. Not very far from the same locality the ship "Mary" reported having seen a reef on which the sea broke. I have grouped these three reports of obstructions to navigation, as, although diligently sought for on several occasions between the years 1815 and 1854, they remain undiscovered. There is nothing in the reports to induce us to believe that they were earthquake shocks: we are instructed that the lead was hove, and soundings obtained, which leads me to conceive that there was an upheaving followed by subsidence, as the soundings at present obtainable in this locality are very deep—2000 fathoms.

I may here mention, that nothing is more difficult to rediscover than isolated portions of rock, even in the vicinity of harbours and roadsteads; how much more so in the open ocean! In the year 1863 the ship "Lightning," one of the Black Ball Line of Australian packets, after clearing Port Philip Heads, but still in charge of the pilot, struck on a rock, but went clear; the ship, not making any water, proceeded on her voyage; the pilot took the bearings of the position; reported the circumstance in Melbourne; went out with some other pilots to discover the hidden danger to vessels passing in and out of Port Philip Heads; *the rock was not to be found;* and opinion varied as to whether the ship struck something moveable, that it was an earthquake, or altogether imaginary. In the mean time the "Lightning" arrived in England, went into dock, and in her bottom was sticking a piece of the rock which the pilots of Melbourne could not discover in the fairway approach to their own port. The rock has since been found, named after the "Lightning," and a buoy placed on it.

My friend, Captain Harris of the "Orient," has mentioned to me an instance somewhat similar:—In the vicinity of the much-frequented port of Dartmouth there is a point of land which, from time immemorial, vessels have been in the habit of rounding close to. Some years since a revenue cutter, in pursuing the same course, struck a rock; the crew had barely time to launch their boat and get clear, when the vessel went down. After a considerable time expended in sounding and diving, a pinnacle of rock was discovered, and removed by blasting. Alas! perhaps many missing vessels have been lost unconsciously, while fearlessly steering a course across the pathless deep, free according to their charts from all impediments to navigation.

Begging to be excused for this digression, I shall return to the volcanic region of the Atlantic. In Lat. 3° N., and 22° W., a ship reported having experienced two shocks, with an interval of an hour between them. Not very far from the same position, in the autumn of 1730 the "Cesar" sighted breakers. Again, in 1860, a ship reported that she grated over what seemed to be a bank of stones, there was a heavy swell running: and the report attributes the sensation to an earthquake.

I now come to the report of three vessels which actually received damage—the "Prince," the "Passadwick," and the "Sea Serpent." In December, 1853, Lat. 0° 54′ N., Long. 26° 50′ W., the "Prince" dragged over some obstruction. When she arrived home, her bottom showed proof of having been in contact with something rough, her copper being very much grazed. In 1859, Lat. 0° 35′ N., Long. 28° 10′ W., the "Sea Serpent" struck what was reported as a shoal, and was considerably damaged.

The Russian corvette, the "Passadwick," picked up the shoal twenty-four hours after the "Sea Serpent," but did not receive so much damage. The position given by these vessels is so constantly visited both by the outward and homeward-bound crossing the Equator, that we might reasonably expect, if such dangers existed, they would be more frequently reported.

The fact of there being no breakers or discoloured water suggests an earthquake; then, again, how could a shock travelling through the sea damage a vessel's bottom?

I find a very full report given by Captain Geale of the "Florence Nightingale," who, while prosecuting a voyage in the year 1859, experienced a severe shock of an earthquake, 48 miles North of the Equator, Long. 29° 16′ W., St. Paul's Islands bearing N. W. by N., distance about ten miles. It commenced with a noise resembling distant thunder, and lasted about forty seconds; plates and glasses were fractured, and loose articles about the deck displaced; the ship felt as if grinding heavily on a reef of rocks; the watch below came tumbling up in great haste, the general impression being that the ship was on shore. Captain Geale states that he was much alarmed, ran to the side of the vessel;

not seeing any symptoms of shoal water, he recollected that possibly it might be an earthquake; and, no further shock being experienced, the general alarm soon subsided. The sky was clear in the morning, but became overcast towards noon, the atmosphere sultry and oppressive, the sea short and irregular, followed by a heavy swell from the N. E.

In Lat. 1° S., Long. 19° W., the "Circassian" in 1840 saw a sandbank under water, 32 miles South of the Equator, and nearly 18 West. The "Triton" found 23 fathoms; and another vessel in nearly the same position observed *black ashes*, and the sea in violent agitation, in 1835. Recent soundings hereabouts show the sea to be very deep—still we have the evidence of these three vessels which obtained soundings, and specimens of the bottom, stated to be a kind of black sand.

Three other vessels—the "Hutchinson," "Chrysolite" and "Crown" —furnish reports referring to the same latitude with a difference in longitude, probably due to their chronometers. The "Hutchinson" struck twice, but after a few moments went clear; no breakers or discoloured water. The "Chrysolite," drawing 16½ feet, struck the ground. The "Crown" grated for a short time. These latter reports are all of a comparatively recent date, being as late as the year 1835.

The following cases I shall briefly notice, without entering into details. Lat. 0° 57′ N., Long. 41° 0′ W., the "Blaesdale" grounded, and remained fast for ten minutes. Lat. 0° 40′ S., Long. 20° 10′ W., the "Philanthropy" scraped along a bank, and shook for three minutes; she spoke an American vessel which felt the same earthquake. Another vessel, 26 miles South of the Equator, Long. 19° 58′ W., experienced violent shaking, loud rumbling noise; man at the helm could not hold it; described it as an awful earthquake, Feb. 1842. 22 miles South of the Equator, Long. 21° 6′ W., the "Aquilla;" loud rumbling noise under the ship's bottom; sensation like that of a vessel sliding over a rock; rudder so much agitated, the man who was steering could scarcely hold the wheel; no discoloured water, or the smallest ripple. Lat. 2° 43′ N., and Long. 20° 35′ W., the "Krusenstern" reported a volcano in May, 1806; the ship trembled, as if striking upon rocks; would not answer her helm; a cloud of smoke arose about the height of the ship's mast, disappeared suddenly, then rose again and vanished altogether; appeared to be distant about ten or fifteen miles; it could not be a waterspout, or a ship on fire, the smoke rose so high. Doctor Horner was of opinion that, if the whole were not an ocular deception, occasioned by refraction of the rays of light, it must have been a volcanic eruption. As this vessel was employed in an exploring expedition, it is to be regretted that they lost the opportunity of verifying an important physical phenomenon, the excuse made being the approach of night, which prevented them examining it sufficiently close. I think the foregoing affords us ample evidence that there exists one or more centres of submarine volcanic action within the area I have indicated.

I may now mention my personal experience. I sailed on the 9th November last from Adelaide in the ship "Orient" bound to London. The "Orient" is 1000 tons register; her draught of water on the occasion 17 feet. Subsequent to leaving port we encountered strong N. W. gales for four days; on the 16th the weather was damp and overcast, the sun breaking out at intervals; the barometer stood at 29·10; similar weather prevailed during the night. At twenty minutes past seven o'clock on the morning of the 17th I was startled by the most unusual and extraordinary sensation I ever experienced, nor have I ever met anything at all similar in my seven years' voyaging round Cape Horn, or my thirteen years of almost continuous maritime experience. The first sensation was the ship trembling all over, and as if on the point of breaking up; then she felt as if grating over a ledge of rocks. I hurried on deck, where general dismay was depicted on the faces of those present. Captain Harris remarked, that he thought the "Orient" was going down under us. Just as I reached the deck she had passed over the danger, and her stern seemed to be drawn down just as the grating sensation ceased. On ascertaining that the ship did not make any water, confidence was restored, and speculation became rife as to the nature of our adventure: some thought we had passed over a submerged iceberg, others differed in opinion as to its being a newly discovered shoal, with fortunately just sufficient water to carry our ship over, or that it was a submarine volcano; this latter was the opinion of Captain Harris and some other scientific persons on board. The deep sea lead was put over the side as soon as it could be obtained, some two or three minutes after the occurrence; no bottom was found at 50 fathoms. The water was not discoloured, nor was there any unusual agitation; the barometer stood at 28·80, there was no change in the weather before or after to account for the fall of three-tenths, the difference in the reading of the 16th and 17th; the barometer continued to rise every day up to the 27th, when it stood at 3000. The thermometer on the morning of the 17th indicated a temperature of 46, the water 48, the wind N. N. E., moderate. The position of the occurrence, as accurately as we could obtain it, was Lat. 51° 44′ S., Long. 170° 49 E. The Auckland Islands bore about N. E. 210 miles. I may add that the ship's bells rang fore and aft; glasses were displaced from the rack in the saloon; the ship's compasses were not affected; the rudder moved freely; there was no difficulty experienced in steering, nor did the man at the wheel notice anything peculiar, except the drawing down of the ship's stern.

Taking advantage of my being in London a few days since, I visited the "Orient" for the purpose of ascertaining if she exhibited any trace on her copper of being in contact with anything, the impression being still very strong on my mind that she had grated over a shoal. The ship had just come out of dry dock, where she had been carefully examined, but not the slightest trace or evidence of her being in contact with the ground could be discovered. We must, therefore, come to the conclusion that the occurrence I have narrated was occasioned by a volcanic shock. Still it does appear to me most difficult to understand how any vibration or earthquake shock passing through water so deep could produce a sensation so exactly similar to that of going over a solid obstruction. I may here point out on the chart and diagram before you, some of the reported shoals and earthquake shocks I have just referred to. Having drawn your attention to the evidences we have of submarine volcanic action, I may remind you that we have many islands in the southern seas at a considerable distance apart from each other, the majority of which, although exhibiting no evidence of active volcanic agency at present, are yet records of what once took place in this vast ocean.

The Island of Annabon, in the Bite of Biafra, is one of four volcanic islands—the other three being St. Thomas, Prince, and Fernandi Po. The truncated pyramidal peak Dofogo, in the island of Annabon, has an elevation of 3250 feet. These islands lie in a line of direction S.S.W. and N. N. E. with the volcano of Leba, 13,000 feet high, in the Cameroon range of African mountains.

Fernando di Noranha, 800 feet with its group of small islets, is distinctly volcanic; there is no crater in this island. Ascension, 2867 feet, has basaltic lavas; masses of scoria have been thrown out from the Green Mountain, where also are to be found angular fragments of granite. On the Western aspect is a large open crater; numerous volcanic bombs, twelve inches in diameter, lie scattered about.

St. Helena, 2692 feet, is entirely volcanic; near the shore the rocks are basaltic, traversed by dykes. In the interior are beds of lava. Between Diana's Peak and Nest Lodge are the remains of a great crater; here scoria and cellular lava abound. Trinidad, 2020 feet, is a mass of volcanic rock, rising abruptly from the sea. The interior is chiefly composed of greenstone; the Sugar Loaf Hill, and the Nine-pin Rock of Trap. The Nine-pin Rock is 850 feet high, in the form of an exquisitely proportioned column. The small islands of Martinvas, in the vicinity, are also volcanic. Tristan d' Acunha 8300 feet, as also Nightingale and the other islands adjacent, are volcanic.

Thompson and Bouvet Islands, Lat. 54° S., are masses of volcanic rock, traversed by veins of lava, presenting a vitrified appearance: black, white, blue and green, sparkling in the sunshine of this icy region, present unmistakeable signs of the origin of these islands. Bridgman Island, one of the South Shetland group, still sends forth hot vapours amid its beds of ice. In the island of Deception, in 1842, flames were seen to issue from thirteen distinct points. In all this group obsidian, black ashes, and pumice abound.

The islands discovered, or rather rediscovered by Captain O'Donnel, of the "James Baines," in Lat. 53° S., are probably, judging from the description given by him, volcanic, and possibly of a more recent date than other portions of isolated land in the South Atlantic.

Some years since I sighted the Crozettes, or Desert Islands: from the peaked appearance of the land, it was at first mistaken for an iceberg. The shape and general aspect of these islands reasonably lead us to believe that they are of similar origin.

However, there can be no doubt about New Zealand and the Aucklands. The capital of New Zealand is, in fact, founded on an extinct volcano. Earthquake shocks are not unfrequent in Wellington Straits. The sea level has undergone considerable change at Taranakee; the water flows over what a few years since was dry land, and rollers come in on the coast at intervals, which is attributed to submarine volcanic eruptions. Indeed, from what I have heard of these islands, I assume that they are situated in one of the volcanic centres of the South Pacific Ocean. Possibly the "Orient" passed over another.

Diego Ramarezes Islands, and indeed all the islands forming the Cape Horn group, are volcanic, while the Falklands and South Georgia exhibit no evidence of volcanic origin. Much of the land discovered within the Antarctic Circle is described as volcanic; and most of us remember Sir James Ross's graphic description of the eruption of Mount Erebus within the stupendous icy barrier of the Antarctic Zone. North of the Equator, and within the area that I have already dwelt on, St. Paul's Islands remain a record of some past submarine convulsion.

In the vicinity of St. Michael's, one of the Western Islands, at the commencement of the present century, an island was thrown up in one night, without any remarkable circumstance to attract the attention of the inhabitants of Villa Franca, who were astonished when they awoke in the morning to find an island where the day before was deep water. A fisherman went to reside on it; but the island went down one night, taking the fisherman and family with it, leaving a dangerous reef which still obstructs the entrance to the harbour of Villa Franca. I may remark that St. Michael's still possesses an active volcano.

I need scarcely mention the volcanic action going on in the Mediterranean at present. The beautiful engraving in the "Illustrated London News" of the submarine volcano and Island of Santorin, has probably been seen by most persons present; but a few general remarks on earthquakes may not be deemed an inappropriate conclusion to this paper. The destruction of life and property occasioned by them, and the mysteriousness of their cause, have at all times forced them on the attention of mankind. It is estimated that upwards of a dozen earthquakes, destructive of life and property, occur upon the surface of the globe every year. Fertile districts have been laid waste, and enormous numbers of human beings destroyed; sixty thousand perished in the great Lisbon earthquake; by an earthquake in Calabria forty thousand were destroyed; and it is estimated that as many as thirteen millions of the human race have thus perished. No portion of the earth's surface is free from earthquakes. Egypt has been more exempt than any other country; but there is a record of one which took place in the year 1740.

The cause of earthquakes is very obscure, and many theories have been brought forward to account for them. All agree as to their connexion with volcanoes, and that they are produced by the same subterranean agency. Sir Humphrey Davy, when he discovered the metallic basis, suggested the idea that those metals might abound in an unoxidized state beneath the crust of the earth; and that when water came in contact with them gaseous matter would be set free, sufficient to produce the earthquake; the metals would combine with the oxygen of the water, and the heat evolved melt the surrounding rocks.

Mr. Mallet looks on an earthquake as the transit of a wave of elastic compression, in any direction, vertical or horizontal, through the crust of the earth, from a centre of impulse, attended by tidal and sound waves, influenced by the circumstances of position as to sea and land. He assumes that the centre of disturbance must be always near a large supply of water. He conceives that, when an eruption takes place at the bottom of the sea, large fissures are opened, through which the water is poured on to a heated surface, and assumes the spheroidal state. No impulse at this time will travel far, except the trembling which precedes the shock. When the water comes in contact with a cooler surface, then a vast volume of steam is evolved into the deep and cold water of the sea. The power thus set free at the volcanic focus is transferred in all directions, and constitutes the true earthquake shock. It travels with immense velocity from the centre of impulse; the rate of translation being as much as thirty miles an hour, its amplitude several miles. During the passage of the main undulation, a continuous tremor, with a short quick action, like a chopping sea, is often felt; this arises from secondary waves, like the small curling swell often seen on the surface of the ocean. When the roll reaches the sea, it lifts the water, and carries it in an elongated heap far out into the deep. The shock of the Lisbon Earthquake was felt in Finland, Canada, and some of the West India Islands—an area of 7,500,000 square miles. Supposing that but twenty miles of the earth's crust were moved, then 150,000,000 cubic miles of solid matter were displaced. The returning wave at Cadiz was sixty feet high: the power evoked must have been truly fearful.

Recently a missionary vessel was swept along by the force of one of these volcanic rollers, until she came in contact with a reef, over which she was fairly carried, and wrecked to leeward among coral rocks. Some years since a number of these rollers, on a fine calm day, poured into the anchorage at St. Helena, tearing the vessels from their moorings, and casting them on shore without the slightest warning. In deep water these waves may be so long as to pass under a ship without being observed; but on a sloping shore the depth of water becomes less than the altitude of the waves, and breaks on the shore with great force, in some instances extending far inland.

The least destructive form of earthquake is the undulatory. If the motion is perpendicular, the devastatation occasioned is frightful; either radiating from a centre, or extending over a considerable line, according to the nature of the original impulse. Sometimes only a few shocks occur, but of sufficient force to spread desolation over hundreds of miles; in other cases as many as 200 have been experienced in twenty-four hours.

Humboldt remarks that, if we were aware of the daily condition of the earth's surface, we should probably ascertain that the earth is always undergoing shocks at some points of its surface. Some very important permanent results remain after great earthquakes; elevations and subsidence are the consequences of those throes.

The power of the great sea wave already alluded to was very remarkable in the Jamaica earthquake of 1692. We read that the "Swan" Frigate, which was lying at the wharf at Port Royal, was borne by it over the tops of houses, and that many persons escaped by clinging to her. Vessels in the vicinity of the island felt the shock of this earthquake severely. On board of one ship, 100 miles from the coast, the men on deck were violently thrown upwards to the height of a foot and a half.

On the coast of Chili and Peru rollers attributed to submarine volcanic action occasion vessels to drive from their anchors, and sometimes cause their destruction.

In conclusion, I may indicate the geographical position of some of the islands which I have referred to in the paper I have had the honour of reading to this meeting.

XXXI.—FURTHER NOTES ON THE CLASSIFICATION OF THE ROCKS OF NORTH DEVON. By J. BEETE JUKES, M. A., F. R. S.

[Read before the Royal Geological Society of Ireland, December 8, 1865.]

IN the month of September last I was able to make another hasty visit to North Devon, with the object of continuing the comparison of the rocks there with those of the South-west of Ireland, and especially of examining the rocks of Lynton and Ilfracombe, which I had not previously seen.

With this object in view, I carefully reperused the paper in the 5th volume of the "Transactions of the Geological Society of London," by Professor Sedgwick and Sir R. I. Murchison, "On the Physical Structure of Devonshire." To whatever extent I may now feel myself compelled to differ from the authors of that paper in some of their views, let me here record my admiration of their graphic descriptions of the external features and internal structure of the country, and the bold and masterly conceptions they formed of it—conceptions which could only have resulted from a laborious and patient examination of the whole district of Devonshire and its borders. I must also acknowledge that any one who confines his attention to Devonshire will feel convinced, not only of the accuracy of their descriptions of the rocks, but of the correctness of their classification of them into several successive groups. There is nothing to be seen in Devon to lead any one to suspect that the apparent order of superposition of these rock groups is not their real order. The general dip of the rocks is to the south. These rocks are very well seen in the cliffs of the north coast, and in the ravines of the brooks which run out on to the north coast. As we trace these brooks up, however, towards the watershed of the country (which is not more than four or five miles distant), these ravines rapidly close in, and become shallow *valleys*, so that near the watershed the exposures of rock, whether natural or artificial, become very few. After crossing the watershed, however, the southern brooks begin soon to cut their valleys into deep ravines and glens, and exhibit corresponding sections of the rocks again. It unfortunately happens that, where the crest of the country running westwards from Exmoor strikes out upon the west coast in Morte Bay, the rocks do not form cliffs upon the sea shore, being backed by large and lofty sandhills, behind which the ground rises, with smooth grassy slopes, into a down. This is called Pickwell Down; and the high ground running eastward from it forms a succession of gently undulating heathery moorlands, or downs, for thirty or forty miles into the country. The summits of these round-topped, smoothly-sloped hills rise to heights varying from 1000 to 1400 feet above the sea. It often happens that no exposure of rock larger than a small wayside quarry is to be seen on these moorlands for three or four miles in every direction, and yet it is along this very central band of high ground that I believe the key to the structure of the country is to be sought, and probably sought in vain.

Had there been a clear coast section along Morte Bay, or a sufficient exposure of rock across the line of downs that run from Pickwell Down to Dulverton Common and Haddon Down, the structure of North Devon would not have remained an unsolved problem till the present day. As it is, I believe that problem to be not only unsolved, but that its solution is not possible by anything to be observed within that country itself; and the facts observable there must be interpreted by the knowledge acquired in some other district, where the same rock groups are more fully displayed, and their real order of superposition can accordingly be more certainly determined.

One reason for thinking the apparent not to be the real order of succession of the rock groups springs from the examination of Devon itself; and that is the extraordinary thickness they must possess on the commonly received hypothesis.

The distance from Lynton to the Coal-Measure boundary, near South Molton, is about fourteen miles in a straight line, measured directly across the strike. The rocks both along this line and everywhere else have a prevailing dip to the south, with a few minor undulations or contortions. The inclination is slight on the north coast, but increases as we go south to a very high angle.

Mr. Weaver, whose accuracy of observation no Irish geologist would be inclined to question, divides the rocks of North Devon into eight groups, thet wo uppermost of which—his (7.) Wavellite Schists and limestones, and his (8.) Culmiferous Shale—belong to the Coal-measures, the six others being the rocks since called Devonian. These, he says, form one *consistent consecutive* series, and he divides them into—1. Foreland Sandstone; 2. Lynton calcareous slate; 3. Trentishoe quartzy slates and sandstones, including the Combe-Martin limestone; 4. Morte slates; 5. Wollacombe sandstones, flags, and slates; and, 6. Trilobite slates;

and he describes the angle of dip as increasing towards the south from 20° to 80°, the strike being from 10° to 15° N. of W. and S. of E., true bearings.*

But, if we allow the width of this apparently consecutive series to be reduced one-third by the effect of contortion and undulation, and assign a mean angle of inclination of only 30° to a width of 50,000 feet of consecutive beds, we get a total thickness of about 25,000 feet. It seems to me impossible to allow any further reduction to this thickness, if we suppose the beds of North Devon to be really superimposed on each other in a regular order of succession. And it must be observed, that even then we do not reach their base, so that an indefinite addition has to be made for beds hidden by the waters of the Bristol Channel. This result is one that requires a comparison with some other district, where the same beds are exposed, either for correction or verification.

We have such a district in the South-west of Ireland, and the hypothesis I now offer for the interpretation of the North Devon section is based solely on the experience acquired by myself, and my colleagues of the Geological Survey in the southern counties of this country. I believe that the county Cork and the adjacent parts of Kerry must be taken as the typical district for the classification of the Devonian rocks, and that the grouping of the rocks of the South of Ireland, resulting from the labours of Sir R. Griffith and Her Majesty's Geological Survey, must form the model for the grouping of the same beds in other countries.

I do not, of course, mean to assert that the rock groups of other countries must necessarily be the same as those of Ireland; but I certainly must maintain that, as the rocks of Ireland are clearly shown, and their order of succession can be observed in many localities, that order must be presumed to be the one which prevails in Devonshire, and in Western Europe generally, in all places *where no good reason can be shown to the contrary.*

It happened that Devonshire was described before the South-west of Ireland, and described by masters in our science. Had those describers however, been previously acquainted with the structure of the South-west of Ireland, they would have had reason to suspect that the apparent order of superposition in Devonshire was not the true one, and would doubtless have interpreted the sections in North Devon by the light of their previous Irish experience. Any one who has gained this experience will, I believe, agree with me in the ideas I have formed respecting the structure of North Devon. I shall not, on the other hand, be at all surprised, if any one without this experience, who looks solely to North Devon itself, declines to accept them.

My hypothesis is briefly this—that a great fault, with a downthrow to the north, strikes from the northern corner of Morte Bay, about east and by south, all across North Devon, somewhere near the villages of West Down, Bittadon, East Down, Challacombe, about a mile south of Simonsbath, and thence onwards in the same course.

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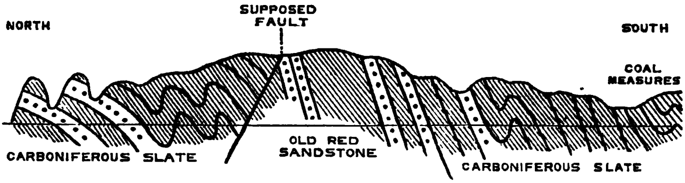
* See "Proceedings of the Geological Society of London," vol. ii., p. 589; paper read January 3, 1838.

The diagrammatic section in fig 1 will express in a general way, without reference to any particular line of country, what I believe to be the true structure of the district between the British Channel and the latitude of Barnstaple and South Molton.



Immediately south of the line of fault above mentioned, the country, wherever I have examined it, from Morte Bay to Dulverton, shows a great thickness (from 3000 to 7000 feet) of rocks which are identical in character with the Old Red Sandstone of Ireland, and precisely like what much of that of South Wales would be if it were sufficiently indurated, and traversed by slaty cleavage.

This Old Red Sandstone dips south at a high angle, and passes under dark grey and black slate identical in character with the Irish Carboniferous slate, and that dips south under a great thickness of other rocks equally identical with the Irish Coal-measures (see p. 115). But to the north of the line of the supposed fault above mentioned there is a great succession of other rocks also dipping south, and appearing, therefore, to pass under those which I have called Old Red Sandstone. There is no place, so far as I could learn by my own search, where the actual junction between this Old Red Sandstone and these apparently lower rocks is to be seen, neither can I find any such place described by any other observer. Where all the rocks dip to the south, the natural conclusion is, that the southern rocks are the higher, and that the rocks farthest north rise up from beneath all the rest. According to the observable facts, therefore, the rocks on the north coast of Devon, about Lynton, should be the lowest group; and all these rocks—those, namely, of Lynton, Combe Martin, Ilfracombe, and Mortehoe—should dip under those rocks which I have called the Old Red Sandstone above.

But I found, to my surprise, that the rocks about Lynton were precisely identical in lithological characters with the lower part of the Carboniferous Slate of Ireland, and the numerous fossils they contained seemed to my eyes to be the same fossils. That some of the fossils are the same is admitted on all sides; and as for the other fossils, they are, at all events, not an Upper Silurian assemblage of fossils, nor belonging to any assemblage which are elsewhere known to be below anything like Old Red Sandstone.

The non-fossiliferous grey slates which lie above the Lynton beds, striking out in one direction on the coast about Ilfracombe and Mortehoe, and in the other running through the country to Simonsbath and Exton, are also precisely like the higher non-fossiliferous portion of the Carboniferous Slate of the county of Cork.

We can in Ireland penetrate down into the purple and green slates and sandstones of the Old Red Sandstone to a depth of 10,000 or 12,000 feet, in numerous glens and valleys in Cork and Kerry; but we never meet below the highest red beds any such groups of grey slate as those of Ilfracombe or Lynton; nor do we find any beds containing marine fossils at all. I believe, then, that the grey slates of Lynton and Ilfracombe are really part of the Carboniferous Slate of Ireland, and, like it, lie wholly above the Old Red Sandstone; and as the red beds which range across North Devon, from Morte Bay to Haddon Down, are exactly the same as the Irish Old Red Sandstone, I believe them to be brought up by a great fault running along the line before mentioned.

If this interpretation be the correct one, and even in Devon itself there is no conclusive evidence against it, it will follow that the subdivision of the rocks into the Upper, Middle, and Lower Devonian, which seemed inevitable as long as the central band of Old Red Sandstone was believed really to lie in the middle of the series, becomes unnecessary.

The rocks of the north coast, the Lynton beds, and the Ilfracombe beds, will thus be placed on the same general horizon as those of Baggy Point and Barnstaple; and the classification of the rocks of Devonshire will assume the same simple type as those of Cork, viz.,

3. Coal measures;
2. Carboniferous Slate, or Devonian beds;
1. Old Red Sandstone.

We know that the Carboniferous Slate of Ireland—a name first proposed by Sir R. Griffith—is a very variable formation; and that, in tracing it from the shores of Cork Harbour to those of Bantry Bay, it acquires so great a bulk of hard quartzose grits below (called by us Coomhola grits), with so many more and thicker calcareous bands above, that it would be easy to make mistakes in its classification, if we were not able to trace a definite boundary below it by following the red and green slates and grits of the Old Red Sandstone continuously across the country.

In Devonshire it seems to become still more variable, or at least variable in another direction, by taking in great banks of limestone. These are most conspicuous in South Devon; but they show themselves about Combe Martin, in North Devon, while in the intermediate Barnstaple country they are as insignificant as they are near Bandon and Kinsale.

Where the sandstones prevail we get occasionally a peculiar set of fossils, which do not occur elsewhere (several species of Cucullæa, &c.); where the limestones become thick and important, other genera make their appearance (the Stringocephalus, for instance). Even in the slates themselves there is a good deal of difference in the assemblages of fossils that occur in different localities. This is the case in Cork and Kerry; it is therefore not surprising that it should also be the case when we compare the fossils of Devon with those of Ireland, or those of different Devonian localities with each other.

There are, however, certain species which I believe prevail throughout the slates, whether they contain inlying bands of limestone, and peculiar sandstones, or not. These species are the most common and abundant species everywhere; and it is a fact of no little significance that most, if not all, of these species occur also in the Carboniferous Limestone.

I have previously expressed the belief that the Irish Carboniferous Slate must be taken to be contemporaneous geologically with the Carboniferous Limestone. I now believe that the same classification will have to be extended to the Devonian beds when the Old Red Sandstone is detached from them. The hypothesis I propose will effect that for North Devon; while for South Devon, although I have little personal acquaintance with the district, I have, from the perusal of the published descriptions, a confident expectation that it will likewise be found easy to detach a set of non-fossiliferous beds, probably bright red and variegated slates and sandstones, to form an Old Red Sandstone base, the beds above them being a peculiar form assumed by the Carboniferous Slate.

In my former paper I alluded to the apparent possibility of tracing a genuine Old Red Sandstone in the Rhine country between the Upper Silurian beds and the Devonian beds, as proposed by the late Mr. Daniel Sharpe, in his paper in the "Quart. Jour. Geol. Soc. Lond.," vol. ix., p. 23, 1853; but on that point I have no new information to add.

XXXII.—NOTES ON ANIMAL MECHANICS. By the Rev. SAMUEL HAUGHTON, M. D., Fellow of Trinity College, Dublin.

[Read before the Royal Irish Academy, April 23, 1866.]

No. IX.—ON THE MUSCLES OF THE MARSUPIALS.

MY observations on the muscles of the Marsupials were made on four Kangaroos, an Opossum, and a Phalanger, which died in the Zoological Gardens of Dublin. One of the Kangaroos was the Giant Kangaroo, a female, which had lived for nine years in the Zoological Gardens, and died in January, 1866, after a fortnight's illness, of paraplegia, produced by cold and damp. The other Kangaroos were Wallabys, two female and one male, which died in 1865–66, of scrofulous disease of the lower jaw, presenting similar symptoms in all, and apparently produced by the damp climate of Dublin, from the pernicious effects of which no care seemed sufficient to protect them. The Opossum (female) was from Virginia, and died in January, 1866, and the Phalanger died in 1864. The stomach of the Opossum contained thirty-four lumbrical worms.

PART I.—KANGAROOS.

In describing the muscles of the Kangaroos, I shall refer to them in the following manner:—

a, *Macropus giganteus* (female).
b, *Macropus Vallabiensis* (male).
c, ,, ,, (female).
c′, ,, ,, (female).

A.—*Muscles of the Hip Joint.*

1. *M. iliacus,*	a,		1·71 oz.
M. psoas magnus,	a,		0·57 oz.
M. psoadiliacus,	a,		2·28 oz.
,,	b,	1·07	1·04 oz.
,,	c,	1·00	

The *iliacus* takes its origin from the surface of the ilium, marked in Fig. 25, and the *psoas magnus* from the bodies of the last two lumbar vertebræ.

2. *M. pectinæus,*	a,		0·36 oz.
,,	b,	0·20	0·25 oz.
,,	c,	0·31	

This muscle takes its origin from the pectinæal line, behind the spine of the pubis, and acts as one of the depressors of the marsupial bones; it is inserted into the second fourth of the linea aspera.

3. *M. adductor brevis,*	a,		0·25 oz.
,,	b,	0·25	0·21 oz.
,,	c,	0·17	

This adductor takes its origin from the anterior line of the pubis, inside the *adductor magnus*, and is inserted into the upper fourth of the linea aspera. It acts as a depressor of the marsupial bone.

4. *M. adductor magnus,*	a,		5·22 oz.
,,	b,	3·53	2·96 oz.
,,	c,	2·39	

The *adductor magnus* takes its origin from the anterior edge of the pubis, from the base of the marsupial bone, from the symphysis pubis, and from the top of the pubic arch; and is inserted into the whole length of the linea aspera. It acts as a depressor of the marsupial bone.

5. *M. adductor longus,*	a,		3·42 oz.
,,	b,	2·31	1·93 oz.
,,	c,	1·56	

This muscle takes its origin from the anterior two thirds of the pubic arch, and is separable with difficulty from the *adductor magnus*, over which it is folded like the double *adductor longus* in the Emu; it is inserted above the back of the inner condyle into the lower fourth of the femur.

6. *M. obturator externus,*	a,		1·42 oz.
,,	b,	0·94	0·80 oz.
,,	c,	0·66	

This muscle has a common tendon with *obturator internus.*

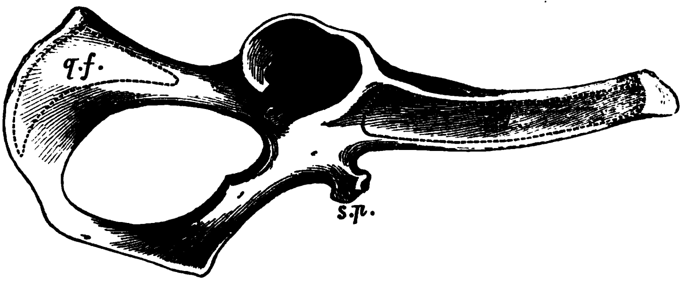
7. *M. Obturator internus,*	a,		0·34 oz.
et gemelli,	b,	0·27	0·29 oz.
,,	c,	0·32	

The origin of these muscles is shown in Fig. 26 (*o. i.* and *g.*), where it will be observed that the origin of the gemelli occupies a larger surface of the ischium than is usual in other animals.

8. *M. quadratus femoris,*	a,		1·47 oz
,,	b,	1·02	0·91 oz.
,,	c,	0·81	

This is one of the most remarkable muscles found in the Kangaroos, and is intended to assist in the support of the animal when resting in its usual attitude, on the tail and hind legs. It takes its origin from the large triangular surface of the ischium, Fig. 25 (*q. f.*), and, thence converging in a pyramidal mass to a point, is inserted into a special trochanter or tubercle, developed for its reception in the middle of the posterior surface of the femur. Fully two-thirds of this pyramidal mass are composed of tendinous fibres, the remaining third being muscular, so that the whole may be regarded as an elastic tendon. When the animal sits upon its tail and legs in the manner above described, it places its feet so far forward, and its tail so far back, that a mechanical observer is at once struck by the apparent want of strength of the arch on which the weight of the body is supported, and is disposed to come to the conclusion that the act of sitting on its tail must be a fatiguing one to the Kangaroo. Observation of their habits, however, abundantly proves the contrary, and shows that the animal prefers this attitude to any other.

Fig. 25.



The explanation of the difficulty is to be found in the semimembranous *quadratus femoris,* which acts as a "*tie-beam*" to the arch, and, without much expenditure of force, supports the weight of the body placed on the vertex of the straddling arch formed by the tail and hind feet. I do not know of any other animal in which the insertion of the *quadratus femoris* is placed so low down on the femur, nor of any in which, as in the Kangaroo, a special trochanter is provided for this muscle.

9. *M. agitator caudæ,*	a,		5·09 oz.
,,	b,	2·20	1·94 oz.
,,	c,	1·91	
,,	c′,	1·70	

This muscle takes its origin from the sides of the 1st, 2nd, and 3rd caudal vertebræ, and joins the posterior portion of the *glutæus maximus* in a long tendon, which is inserted into the side of the patella and lower margin of the *vastus externus.*

10. *M. glutæus maximus posterior,*	a,		6·06 oz.
,,	b,	2·64	2·01 oz.
,,	c,	1·73	
,,	c′,	1·67	

takes origin from the sacral fascia and from fascia covering *gl. medius;* is separable with difficulty from *gl. max. anterior,* and is inserted by common tendon with the *agitator caudæ.*

11. *M. glutæus maximus anterior,*	a,		2·46 oz.
,,	b,	1·92	1·65 oz.
,,	c,	1·54	
,,	c′,	1·48	

This muscle takes its origin from the anterior margin of the ilium, behind the origin of *sartorius,* and from the lumbar fascia and that covering the *gl. medius;* and is inserted into the fascia flowing over the great trochanter that gives origin to the *vastus externus.*

12. *M. glutæus medius,*	a,		9·47 oz.
,,	b,	2·53	2·71 oz.
,,	c,	2·90	

Origin from the posterior edge of the ilium, from the ischiadic notch forward, and from the surface of that bone, marked in Fig. 26 (*gl. med.*)

13. *M. glutæus minimus,*	a,		0·62 oz.
,,	b,	1·16	0·74 oz.
,,	c,	0·32	

This muscle takes its origin from the surface of the ilium, marked Fig. 26 (*gl. min.*), and is inserted into the line below the head of the great trochanter, by means of a flat tendon.

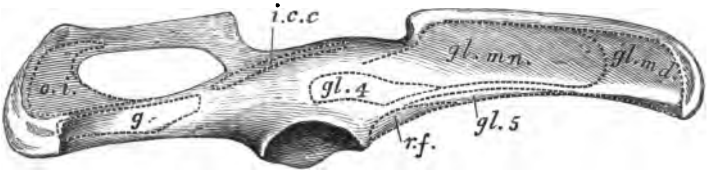
14. *M. glutæus quartus* (*iliocapsularis*),	a,		0·49 oz.
„	b,	0·39	0·27 oz.
„	c,	0·16	

This is the muscle described by human anatomists under the name of *ilio capsularis*, as sometimes occurring in the human subject; it belongs to the glutæal group, and not to the iliacal group of muscles, and arises from the surface of the ilium, marked in Fig. 26 (*gl.* 4); and it is inserted by a flat tendon into the prolongation of the insertion of the *glutæus minimus*, with which its action is almost identical.

15. *M. glutæus quintus*,	b,		0·26 oz.

takes origin from the lateral ridge of the ilium, Fig. 26 (*gl.* 5), separating the glutæal from the iliacal surface, and is inserted by flat tendon below *glut. quartus*.

Fig. 26.



16. *M. pyriformis*,	a,		0·44 oz.
„	b,	0·20	0·18 oz.
„	c,	0·16	

This muscle is well developed, and is quite distinct from the *glutæus medius;* it has the usual origin, and is inserted partly into the head of the great trochanter, and partly into the fascial origin of the *vastus externus* that flows over that trochanter.

B.—*Muscles of the Knee Joint.*

1. *M. tensor vaginæ femoris*,	a,		0·84 oz.
„	b,	0·44	0·36 oz.
„	c,	0·28	

This muscle takes its origin from 1¼ inch of the anterior superior portion of the lateral ridge of the ilium, below the origin of the *sartorius*, and is lost in the fascia directly covering the *rectus femoris* halfway down the thigh. I class it, from its connexion with the *rectus*, among the knee joint, rather the hip joint muscles.

2. *M. rectus femoris*,	a,		4·42 oz.
„	b,	2·50	1.94 oz.
„	c,	1·38	
3. *M. vastus externus*,	a,		10·14 oz.
„	b,	4·30	3·95 oz.
„	c,	3·60	

This large muscle takes its origin almost exclusively from the glutæal fascia flowing over the great trochanter, and has only a few fibres arising from the side of the femur; and some fibres of the *pyriformis* are attached to its posterior border.

4. *M. vastus internus*,	a,		1·89 oz.
,,	b,	1·42	1·19 oz.
,,	c,	0·96	
5. *M. cruræus*,	a,		1·37 oz.
,,	b,	0·78	0·78 oz.
,,	c,	0·78	
6. *M. sartorius*,	a,		2·71 oz.
,,	b,	1·15	1·12 oz.
,,	c,	1·08	

This muscle has the usual origin, but is inserted subcentrally into the patella, rather on the inner side; it bears a close resemblance to one of the *sartorii* in the Dog.

7. *M. gracilis*,	a,		2·13 oz.
,,	b,	1·16	1·04 oz.
,,	c,	0·92	

This muscle acts as one of the depressors of the marsupial bone, and is inserted by a broad tendinous fascia into the upper third of the leg.

8. *M. semimembranosus*,	a,		1·18 oz.
,,	b,	0·73	0·84 oz.
,,	c,	0·94	

takes its origin from the middle third of the arch of the pubis, and is inserted by a narrow tendon into the top of the tibia; it is with difficulty separable from the *adductor magnus*.

9. *M. semitendinosus*,	a,		4·47 oz.
,,	b,	2·31	2·19 oz.
,,	c,	2·06	

This muscle arises from the tuber ischii, as usual, with a few fibres, forming the posterior border of the *gl. max.* from the first caudal vertebra; and is inserted by a tendon, 1½ in. to 2¼ in. long, into the upper third of tibia, by fascia common to it and to *gracilis*.

10. *M. biceps femoris*,	a,		14·98 oz.
,,	b,	6·62	6·13 oz.
,,	c,	5·64	

The *biceps* is blended, near its origin, with some fibres of the *semitendinosus*, and is inserted into the fascia of the thigh immediately below the great trochanter, into the lower part of the patellar fascia, from one-third to halfway down the leg.

11. *M. poplitæus*,	a,		0·68 oz.
,,	b,	0·27	0·24 oz.
,,	c,	0·20	

C.—*Muscles of Ankle and Foot.*

1. *M. gastrocnemius*,	a,		7·47 oz.
,,	b,	2·68	2·36 oz.
,,	c,	2·04	

Origin; on the outer side, from the back of the outer condyle, from tendon of *agitator caudæ*, and from under surface of one horn of the crescentic sesamoid bone lying below the outer condyle at the top of fibula; on the inner side, from the back of the inner condyle.

2. *M. flexor communis perforatus*,	a,		6·85 oz.
,,	b,	2·62	2·37 oz.
,,	c,	2·11	

Origin; from the inner horn of the crescentic sesamoid bone, with some fibres from the fascia of knee joint and outer condyle.

Insertion; at the calcaneum, the tendon is partly inserted on its inner side, and then passes on over the calcaneum (representing the *flexor brevis digitorum*), and is distributed (as *flexor perforatus*) to the near ends of both phalanges of the two large toes; at the outer side of the heel it gives off a smaller tendon, which runs direct to the *outer* of the large toes, and is joined near its base by a second tendon from the main trunk; both united form the *flex. perforatus* of that toe. It seems to contain the *solæus, plantaris,* and *flexor digitorum brevis* combined in one.

3. *M. flexor communis perforans* (*longus*),	a,		2·61 oz.
,,	b,	1·36	1·24 oz.
,,	c,	1·12	

arises from the upper two-thirds of back of tibia and fibula, except portion covered by *poplitæus;* and is distributed to the ungual phalanges of the four toes.

4. *M. peronæus longus*,	b,	0·20	0·17 oz.
,,	c,	0·14	

takes origin from the top and upper half of the fibula, and from the fascia covering the other two *peronæi;* and after passing under the foot in the usual manner, its tendon is inserted into the near ends of the metatarsals of the two inner (small) toes.

5. *M. peronæus brevis*,	a,		0·39 oz.
,,	b,	0·12	0·11 oz.
,,	c,	0·09	

Origin from the outer and upper third of fibula, and insertion into outer side of distal end of metacarpal of outer toe, and base of its first phalanx.

6. *M. peronæus tertius*,	b,		0·01 oz.

This little muscle arises from the middle of the fibula, below the other *peronæi,* and is inserted by means of a long silky tendon into the back of the outer and near end of the 1st phalanx of the 2nd toe (small).

7. *M. flexor proprius hallucis*, . b, ... 0·02 oz.

This muscle arises from the fascia covering the back of the *poplitæus*, with a few fibres running towards the head of the fibula; and is inserted into the os calcis, on the *inner* side of the groove made for the passage of the tendon of the *flexor digitorum perforans.*

8. *M. tibialis anticus*,	a,		4·46 oz.
,,	b,	1·91	1·58 oz.
,,	c,	1·24	

Inserted into the inner side of the near ends of the metatarsals of the 1st and 2nd toes (small).

9. *M. extensor communis digitorum*,	a,		1·23 oz.
,,	b,	0·51	0·43 oz.
,,	c,	0·34	

Distributed to the 3rd and 4th toes (large).

10. *M. extensor hallucis*, . . . b, ... 0·02 oz.

This little muscle takes origin from inner side of the head of the tibia, below the *tibialis anticus*, and its tendon, crossing the backs of the metatarsal bones, is distributed by two smaller tendons to the backs of the two inner toes (used chiefly for scratching), of which, with the *peronæus tertius*, it is the proper extensor.

D.—*Muscles of the Shoulder.*

1. *M. trapezius*	a,		0·42 oz.
,,	b,	0·25	0·28 oz.
,,	c,	0·30	

This muscle is intimately blended with the cutaneous muscles of the neck, with the *omo-atlanticus* and *latissimus dorsi;* it takes its origin from the last three cervical and first six dorsal vertebræ.

2. *M. rhomboideus*,	a,		0·17 oz.
,,	b,	0·18	0·18 oz.
,,	c,	0·18	

Arises from the occiput, from all the cervical, and first three dorsal vertebræ.

3. *M. sterno-cleido-mastoideus*,	a,		0·39 oz.
,,	b,	0·33	0·32 oz.
,,	c,	0·31	

4. *M. omo-atlanticus*,	a,		0·45 oz.
,,	b,	0·25	0·26 oz.
,,	c,	0·26	

Arises from the transverse processes of the 1st, 2nd, and 3rd cervical vertebræ, and is inserted into the anterior fourth of the spine of scapula and whole of clavicle.

5. *M. serratus magnus,*	a,		0·97 oz.
,,	b,	0·88	0·89 oz.
,,	c,	0·90	

Arises from the costal processes (pleurapophyses) and ribs of the vertebræ, from the third cervical to the sixth dorsal.

6. *M. subclavius,*	a,		0·05 oz.
,,	b,	0·05	0·05 oz.
,,	c,	0·05	

This muscle takes its origin from the inner fourth, or cartilage of first rib, and is inserted along the whole length of the under surface of the clavicle.

E.—*Muscles of the Shoulder Joint.*

1. *M. latissimus dorsi,*	a,		1·13 oz.
,,	b,	0·71	0·81 oz.
,,	c,	0·90	

In addition to the *lat. dorsi,* occupying its usual position, there is an accessory cutaneous muscle, like that so fully developed in the Seal and other swimming animals, which is inserted, partly with the *lat. dorsi,* and partly over the *biceps,* with the *pectoralis;* it is, properly, a part of the *panniculus carnosus,* and takes its origin as far down as the symphysis pubis.

2. *M. pectoralis,*	a,		0·95 oz.
,,	b,	1·08	1·16 oz.
,,	c,	1·24	

takes origin from the whole length of the sternum. There is only one pectoral muscle.

3. *M. coracobrachialis,*	b,		0·02 oz.
4. *M. deltoideus,*	a,		0·42 oz.
,,	b,	0·36	0·38 oz.
,,	c,	0·40	

Arises from inner third of spine of scapula and clavicle.

5. *M. supraspinatus,*	a,		0·52 oz.
,,	b,	0·52	0·51 oz.
,,	c,	0·49	
6. *M. infraspinatus,*	a,		0·54 oz.
,,	b,	0·62	0·63 oz.
,,	c,	0·63	
7. *M. teres minor,*	b,		0·03 oz.

Arises from the anterior half-inch of lower edge of scapula, and is inserted below the flat tendon of the *infraspinatus;* its action is the same as that of the *glutæus quartus* (*iliocapsularis*).

8. *M. subscapularis*,	a,		0·69 oz.
,,	b,	0·81	0·79 oz.
,,	c,	0·76	
9. *M. teres major*,	a,		0·24 oz.
,,	b,	0·26	0·31 oz.
,,	c,	0·35	

F.—*Muscles of the Elbow.*

1. *M. triceps extensor*,	a,		1·97 oz.
,,	b,	1·23	1·26 oz.
,,	c,	1·28	
2. *M. anconæus*,	a,		0·09 oz.
,,	b,	0·14	0·08 oz.
,,	c,	0·01	
3. *M. biceps cubiti*,	a,		0·35 oz.
,,	b,	0·39	0·45 oz.
,,	c,	0·51	

This muscle, as in the other Marsupials, is in the Kangaroos composed of two muscles:—

a, *Coracoid biceps*,	0·25
b, *Longhead biceps*,	0·14
	0·39

The coracoid biceps takes its origin from the coracoid, and is inserted into the tubercle of the *radius*, as in man and other Mammals.

The longhead biceps arises from the margin of the glenoid cavity of the scapula, and its tendon passes over the head of the humerus; it is inserted with the tendon of of the *brachiæus* into the *ulna*, as in the Crocodile. The two muscles cross each other in their fibres, like a long **X**, or St. Andrew's cross.

4. *M. brachiæus* (*externus*),	a,		0·33 oz.
,,	b,	0·24	0·30 oz.
,,	c,	0·36	

Arises from the outer and posterior surface of the upper part of the humerus, winding round under the external deltoid ridge, inside the origin of the *supinator longus*.

G.—*Muscles of the Wrist and Hand.*

1. *M. supinator radii longus*,	a,		0·25 oz.
,,	b,	0·09	0·15 oz.
,,	c,	0·20	

The tendon of this muscle is distributed to the near ends of the metacarpals of pollex and index.

2. *M. extensor carpi radialis*, . . b, ... 0·14 oz.
Inserted by two tendons into the distal and radial sides of the metacarpals of index and middle finger.

3. *M. extensor digitorum communis*, b, . . 0·10 } . . 0·12 oz.
,, c, . . 0·14

Distributed to the ungual phalanges of the second, third, fourth, and fifth fingers.

4. *M. extensor minimi digiti*, . . b, ... 0·04 oz.
Extends third, fourth, and fifth fingers, and is very distinct from last.

5. *M. extensor carpi ulnaris*, . . b, ... 0·04 oz.
Inserted, as in man, into the outer and near end of the metacarpal of the little finger.

6. *M. extensor ossis metacarpi pollicis*, b, ... 0·09 oz.
Inserted into base of metacarpal of thumb.

7. *M. extensor primi internodii pollicis*, b, ... 0·03 oz.

8. *M. supinator radii brevis*, . . b, . . 0·04 } . . 0·04 oz.
,, . . c, . . 0·03

9. *M. pronator radii teres*, . . b, . . 0·10 } . . 0·11 oz.
,, . . c, . . 0·11
Inserted into upper third of radius.

10. *M. palmaris longus*, ... c, ... 0·03 oz.

11. *M. flexor carpi radialis*, . . b, . . 0·10 } . . 0·12 oz.
,, . . c, . . 0·13
Inserted into base of metacarpal of thumb.

12. *M. flexor carpi ulnaris*, . . b, . . 0·07 } . . 0·07 oz.
,, . . c, . . 0·06

Takes its origin altogether from the edge of the ulna and inner side of the olecranon; and is inserted into the pisiform bone.

13. *M. flexor digitorum communis*, b, . . 0·76 } . . 0·67 oz.
,, c, . . 0·58

This muscle consists of the *flex. sublimis* and *profundus*, and *flex. pollicis longus*, all combined; the flex. sublimis portion takes an extensive origin from the broad flat tendon of *flex. profundus* and *flex. pollicis* just above the wrist, and having past the wrist, divides into four perforated tendons for the second, third, fourth, and fifth fingers.

14. *M. pronator quadratus*, ... b, . . 0·02 } . . 0·02 oz.
,, ... c, . . 0·02

Extends the whole length of both radius and ulna.

H.—*Muscles of the Spine.*

The muscles of the spine may be divided into the Direct and Oblique muscles, according as they pass from origin to insertion from and to similar or different processes of the vertebræ.

The Direct muscles are

1. Interspinal,
2. Intercostal,
3. Intertransversal.

The Oblique muscles are

1. Spino-costal, or costospinal;
2. Spino-transversal, or transversospinal;
3. Costo-transversal, or transversocostal.

Direct Muscles of the Spine.

I. *Interspinal Muscles*, passing from spinous process to spinous process, along the line of vertebræ. There are interspinal muscles developed, more or less, along the column, especially in the dorsal and lumbar portions.

II. *Intercostal Muscles.*—The costal processes of the cervical vertebræ are, as usual, well developed; and in the lumbar region they form broad horizontal expansions, which are continued, with modifications down the whole length of the tail.

a, *M. intercostalis lumbaris* (*quadratus lumborum*),

$$\left.\begin{array}{ll} ,, & c',\ 6\cdot08 \\ ,, & c,\ 7\cdot83 \end{array}\right\} \ . \ . \ 6\cdot96 \text{ oz.}$$

This muscle takes its origin from the interior quadrate surface of the ilium, Fig. 27 (*quad. lumb.*), and from the crest of ilium; and is inserted into the backs of the flat costal processes of all the lumbar vertebræ, into the edge of last rib, and posterior surfaces of next two ribs (extensor of lumbar spine).

b, *M. intercostalis dorsalo-cervicalis*,

$$\left.\begin{array}{ll} & c',\ .\ .\ .\ 2\cdot07 \\ ,, & c\ \ .\ .\ .\ 1\cdot27 \end{array}\right\} \ . \ . \ 1\cdot67 \text{ oz.}$$

From the costal processes of all the dorsals into the backs of the ribs (9 — 1), and of all the cervical costal processes (pleurapophyses), terminating at the mastoid process (extensor of dorsal and cervical spine).

c, *M. intercostalis caudalis superior*,

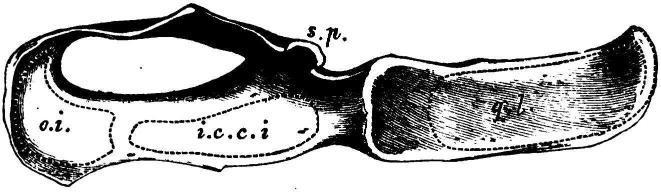
$$\left.\begin{array}{ll} & c',\ .\ .\ .\ 0\cdot68 \\ ,, & c,\ .\ .\ .\ 0\cdot63 \end{array}\right\} \ . \ . \ 0\cdot66 \text{ oz.}$$

This muscle is a horizontal wagger of the tail, and its origin is shown in Fig. 26 (*i. c. c*) from a line on the posterior interior edge of the ilio-ischium; it is inserted into the back of the costal expansion of the sacrum, and into the backs of the costal processes of the caudal vertebræ (1 — 6)—(extensor of caudal spine).

d, *M. intercostalis caudalis inferior*, c', ... 1·70 oz.

Origin from the inner surface of the innominate bone, marked Fig. 27 (*int. cost. caud. inf.*), and from the adjoining under surface of the costal processes of the sacrum; Insertion, into the under surfaces of the caudal costal processes (1 — 9)—(flexor of the caudal spine).

Fig. 27.



III. *Intertransversal Muscles.*

a, *M. intertransversalis caudalis superior*, c', ... 2·82 oz.
,, c, ... 3·50 oz.

From the tips of the upper transverse processes of the caudal vertebræ (4 — 17, &c.); into the outer sides of the transverse processes of the last dorsal, and all the lumbar, sacral, and caudal vertebræ. This series of muscles fills the space between the superior transverse and costal processes in the tail. In the sacral and lumbar region it lies under the *gl. maximus* and *intercostalis lumbalis*—(extensor of lumbar and caudal spine).

b, *M. intertransversalis lumbalis superior*, c', ... 0·56 oz.

joining the superior transverse processes of the lumbar vertebræ—(extensor of lumbar spine).

c, *M. intertransversalis caudalis inferior*, c', ... 1·93 oz.

From the inferior transverse processes (hæmapophyses) of all the caudal vertebræ; into the bodies of the sacral vertebræ, and sides of inferior transverse processes of caudal vertebræ. This series is separated from the *intercostalis caudalis inferior* by the large nerve of the inferior part of tail, which supplies both—(flexor of caudal spine).

d, *M. intertransversalis lumbalis inferior* (*psoas parvus*).

,, a, ... 3·70 oz.
,, b, . . . 2·14
,, c, . . . 1·51 } . . 1·74 oz.
,, c', . . . 1·58

This muscle takes its origin from the spine of the pubis, and is inserted into the bodies of the vertebræ as high up as the diaphragm—(flexor of lumbar spine).

Oblique Muscles of the Spine.

I. *Spinocostal Muscles* (none).

II. *Spinotransversal Muscles.*

a, *M. spinotransversalis lumbalis* (*multifidus spinæ?*) c′, . 3·20 oz.

From the backs of the transverse processes of all the vertebræ from the last dorsal to the third caudal; into the spinous processes of the vertebræ in front, and into the *raphe* above the spinous processes (extensor).

b, *M. spinotransversalis dorsalis*, . c′, ... 0·57 oz.
c, *M. spinotransversalis cervicalis*, . c′, ... 0·58 oz.

From the transverse processes of the cervical and first six dorsal (tubercle in front of rib articulation); is inserted direct into the occiput.

d, *M. spinotransversalis caudalis*, . c′ . . . . . . 0·63 oz.

III.—*Costotransversal Muscles.*

a. *M. spinocostalis lumbalis*, ... c, 0·81 } . 0·85 oz.
(*Sacrolumbalis*), ... c′, 0·88 }

From the anterior crest of the ilium, below the *quadratus* lumborum, into the outer sides of the transverse processes of all the lumbar vertebræ. This muscle acts as a "guy" to the back at either side. It was in a state of fatty degeneration in all the Kangaroos dissected by me.

J.—*Abdominal Muscles.*

1. *M. externus obliquus*, . . . a, ... 5·35 oz.

Takes its origin from the lumbar fascia, and from all the ribs, except the first; and is inserted into the whole length of the Marsupial bone, and into the inner edge of the pubis, above the symphysis, and into the edge of the ilium; it is continuous with the *pectoralis* at the extremity of the sternum.

2. *M. cremaster*, ... a, ... 0·38 oz.
,, ... b, ... 0·09 oz.

This muscle is from six to eight inches in length, and forms the lower border of *transversalis*, and takes its origin from the edge of the ilium. During coition it is reduced to two inches in length.

3. *M. transversalis*, ... a, ... 1·60 oz.

Arises from the superior anterior edge of the ilium, from the lumbar fascia, and from the last two ribs; and is inserted into the fascia of the *internus obliquus*.

4. *M. internus obliquus*, . . . a, ... 2·63 oz.

Arises from the last two ribs, and from the rib cartilages up to the xiphoid extremity of the sternum; and is inserted into the fascia abdominis.

5. *M. rectus abdominis*, . . . a, ... 3·43 oz.

Takes its origin from the first rib and middle line of the sternum and abdomen (27 inches long); and is inserted into the anterior surface and inner edge of the Marsupial bone, of which it is the proper levator.

K.—*Muscles of Mastication.*

1. *M. masseter externus*, . . . a, ... 0·44 oz.

Arises from the outer and lower portion of the zyzomatic arch, from the lower rim of the orbit and malar bone; and is inserted into the posterior fourth of the lower jaw, including the entire external surface of the marsupial horizontal process.

2. *M. masseter internus et M. temporalis*, . . a, . . 1·11 oz.

Inserted into the outer and inner surfaces of the coronoid process, and into the pit on the outer side of bone.

3. *M. pterygoideus internus*, . . a, ... 0·60 oz.

Takes its origin from the inner side of the pterygoid plate, with some fibres from the outer side, and from the fossa between it and palatal plate; and is inserted into the whole of the inner side of the marsupial horizontal ramus of the lower jaw. The action of this muscle is to push the cutting teeth of the lower jaw upwards and forwards against the upper incisors—an action in which it is powerfully assisted by the external masseter.

PART 2.—OPOSSUM AND PHALANGER.

THE following Tables contain the weights of the muscles of the Opossum and Phalanger dissected by me; and, as I have already entered into so much detail with respect to the muscles of the Kangaroos, it is the less necessary to specify particulars, except in the form of notes.

A.—*Muscles of the Hip Joint.*

	OPOSSUM.	PHALANGER.
	Oz. Av.	Grs.
1. Psoas magnus,	0·10	95
2. Iliacus,	0·11	
3. Pectinæus,	0·04	10
4. Adductor brevis,	0·12	—
5. „ magnus,	0·22	88
6. „ longus,	—	44
7. Obturator externus,	0·09	70
8. „ internus, &c.	0·04	
9. Quadratus femoris,	0·02	
10. Agitator caudæ,	0·09	50
11. Glutæus maximus,		45
12. „ medius,	0·15	125
13. Pyriformis,	0·02	
14. Glutæus minimus (distinct, though small),		20

B.—*Muscles of the Knee Joint.*

	OPOSSUM. Oz. Av.	PHALANGER. Grs.
1. Rectus femoris,	0·13	220
2. Vasti,	0·27	
3. Sartorius,	0·05	35
4. Gracilis,	0·11	60
5. Semi Membranosus,	0·16	150
6. Semi Tendinosus,	0·08	77
7. Biceps femoris	0·13	110

N. B.—The *Psoas parvus* in Phalanger weighed 33 grs.

C.—*Muscles of the Ankle and Foot* (OPOSSUM).

	Oz. Av.
1. Gastrocnemius et Solæus,	0·09
2. Plantaris,	0·02
3. Flexor dig. longus (perforans), (Distributed to five toes).	0·06
4. *Tibialis posticus,* (Inserted into near and inner side of the metatarsal of hallux).	0·02
5. Flexor hallucis longus, (Inserted into tarsal bones of hallux).	0.02
6. Peronæus longus,	0·03
7. Tibialis anticus,	0·03
8. Extensor dig. communis, (Four tendons).	0·01
9. Extensor hallucis, (Inserted into near end of first phalanx of hallux).	0·01

D.—*Muscles of Shoulder* (OPOSSUM).

1. *M. trapezius*, ... 0·25 oz.

Arises from the occiput, all the cervical, and all the dorsal vertebræ, except last; inserted into outer half of clavicle, acromion, whole spine of scapula, and vertebral edge of same.

2. *M. rhomboideus*, ... 0·07 oz.

Origin; occiput and spines of all the cervical and first six dorsal vertebræ.

3. *M. sterno-cleido-mastoideus*, ... 0·07 oz.

Origin from top of sternum and inner third of clavicle.

4. *M. omo-atlanticus*, ... 0·03 oz.

Arises from anterior fifth of spine of scapula; and is inserted into the transverse wing of the atlas.

5. *M. serratus magnus*, ... 0·23 oz.

Cervical vertebræ, 2—7; and ribs, 1—8.

6. *M. levator anguli scapulæ*, ... 0·02 oz.

Origin; from under surface of the wing of the atlas. Insertion; into the end of the spine of the scapula.

7. *M. omo-hyoideus*, 0·03 oz.

Origin; from the anterior point of vertebral edge of scapula. Insertion; usual.

8. *M. subclavius*, 0·01 oz.

Origin; from sternal end of first rib. Insertion; under surface of outer third of clavicle, and front of acromion.

E.—*Muscles of Shoulder Joint* (OPOSSUM).

1. *M. latissimus dorsi*, 0·23 oz.

Origin; from the spines of (7—13) dorsal vertebræ, and from lumbar vertebræ by fascia. Insertion; beneath biceps by a tendon *distinct* from that of *teres major;* this tendon also gives origin to a fourth head of *triceps*, which is inserted into tip of olecranon and fascia of back of forearm.

N.B.—There is also an accessory cutaneous *lat. dorsi*, elliptical in shape, near the inner margin of, and inside, the true *latissimus dorsi;* its inner border reaches to the *pectoralis minor*. This muscle weighed 0·09 oz., and was inserted into the pectoral ridge of humerus, by fascia, and in line with insertion of *pectoralis minor*.

2. *M. subscapularis*,	0·14 oz.
3. *M. pectoralis minor* (long slip),	0·08 oz.
4. *M. pectoralis major*,	0·28 oz.
5. *M. coracobrachialis*,	0·01 oz.
6. *M. deltoideus*,	0·13 oz.

Origin; from the outer third of clavicle, acromion, and whole spine of scapula. Insertion; into the inner side of the pectoral ridge, outside *biceps*.

7. *M. supraspinatus*,	0·14 oz.
8. *M. infraspinatus*,	0·10 oz.
9. *M. teres major*,	0·08 oz.

F.—*Muscles of the Elbow*.

1. *M. triceps extensor cubiti*, 0·42 oz.

The fourth slip from *lat. dorsi* weighs 0·02 oz.

2. *M. anconæus*,	0·01 oz.
3. *M. biceps cubiti*,	0·09 oz.

This muscle is double, as in the Kangaroos—

1. *Coraco-radial*,	0·06 oz.
2. *Ulno-scapular*,	0·03 oz.

4. *M. brachiæus* (*externus*), 0·06 oz.

From upper and outer surface of humerus, outside deltoid ridge.

G.—*Muscles of the Wrist and Hand.*

1. *M. supinator radii longus*, ... 0·02 oz.
Inserted into carpal bone of thumb.

2. *M. extensor carpi radialis* (*longior*), ... 0·03 oz.
Inserted into the distal end of the metacarpal of index.

3. *M. extensor digitorum communis*, ... 0·02 oz.
Distributed to second, third, fourth, and fifth fingers.

4. *M. extensor primi digiti* (*indicator*), ... 0·01 oz.
5. *M. extensor minimi digiti*, ... 0·01 oz.
6. *M. extensor carpi ulnaris*, ... 0·03 oz.
Inserted into near end of metacarpal of little finger.

7. *M. extensor ossis metacarpi pollicis*, ... 0·02 oz.

Its tendon crosses those of *sup. rad. long.* and *ex. carp. radialis*, and is inserted into the outer side of the base of metacarpal of thumb.

8. *M. supinator radii brevis*, ... 0·01 oz.
9. *M. pronator radii teres*, ... 0·03 oz.
10. *M. palmaris longus*, ... 0·01 oz.
Inserted into the tendon of the *flex. prof.* in the palm.
11. *M. flexor carpi radialis*, ... 0·02 oz.
12. *M. flexor carpi ulnaris*, ... 0·05 oz.
13. *M. flexor digitorum communis*, ... 0·07 oz.
(*Sublimis et profundus*, { *sublimis*, . . 0·03 oz.
{ *profundus*, . . 0·04 oz.
14. *M. pronator quadratus*, ... 0·01 oz.

J.—*Abdominal Muscles* (OPOSSUM).

1. *M. externus obliquus*, ... 0·32 oz.

Its origin was similar to that described by Prof. Owen in the case of the Phalanger; and its insertion was into the upper and outer half of the Marsupial bone.

2. *M. pyramidalis*, ... 0·05 oz.
Arises from the whole inner margin of the marsupial bone, and is inserted into the raphe from the symphysis pubis as high up as two inches below the end of the sternum.

3. *M. rectus abdominis*, ... 0·21 oz.
Arises from the inner margin of the marsupial bone inside the origin of the *pyramidalis;* and is inserted along the raphe below the end of the sternum, sending upwards a strong distinct slip, which passes under the pectoral muscles and below a remarkable intercostal muscle

(4), to be finally inserted, broad and fleshy, into the sternal ends of the first, second, and third ribs. Its total length is 9 inches.

4. *Intercostal muscle* (referred to above), ...	0·01 oz.

Arises from the lower third of the sternum; and is inserted into the middle of the second rib.

5. *M. cremaster*, ...	0·01 oz.
6. *M. internus obliquus*, ...	0·08 oz.

XXXIII.—ON HÆMODROMOMETERS. By W. HANDSEL GRIFFITHS.

[Read before the Royal Irish Academy, December 11, 1865.]

THERE has long been a question among physiologists as to the velocity with which the blood moves in the arteries. Many of them have made calculations which, had they come from others than men of such repute, would have excited derision; and indeed we can scarcely refrain from smiling when we read that Hales "inferred the velocity of the blood at the commencement of the aorta in man to be at the rate of 735 feet per second."

The celebrated Volkman saw the folly of the deductions drawn from such vague data as these were, and he devised an instrument, which he termed the "Hæmodromometer," the object of which was to *measure* the velocity of the movement of the blood in the arteries.

The results of experiments made with this instrument were, of course, much more reliable than those founded on calculations inferred from data of the most vague and uncertain character; but, while I would unhesitatingly give the preference to the deductions drawn from experiments with Volkman's Hæmodromometer, I can by no means assent to the supposition that they are correct, *or even nearly so*. The use of Volkman's instrument involves great objections; and, although I look on the instrument itself as a model of ingenuity, I cannot regard it as one on which I should depend for a solution of the problem, With what velocity does the blood move in the arteries?

I will proceed to describe as briefly as possible the construction and mechanism of Volkman's Hæmodromometer. I will then consider the objections which I entertain to it; and it is but right that I should afterwards mention how I would propose to rectify these defects.

Volkman's Hæmodromometer consists essentially of a glass tube, which is bent into the form of a hairpin, and is fifty-two inches long. This tube is filled with water; and, by a peculiar arrangement, is placed between the open ends of a cut vessel. For a concise description of this instrument, I beg to refer to Todd and Bowman's "Physiological Anatomy," vol. ii., page 364. In the drawing which is given in that work is represented a tube, which is constructed of metal, and measures one inch and a half in length; it terminates at cones, which fit into other cones, by which means they are adapted to the cut ends of the vessel. The mechanism of the stopcock is indeed an admirable contrivance; and, although easily understood, is rather difficult of description. The handle commands the course of the tube by means of two cogged wheels, so that when it is turned in one direction it allows a free passage *directly* from one end to the other; and when it is turned in the opposite direction *this* free passage is interrupted, and another passage, namely, from one end, *along the hairpin tube*, to the other end is opened; so that at the will of the operator he can open one communication to the exclusion of the other, but he cannot obtain a double communication. The glass hairpin-shaped tube is attached to a board, on which is fixed a scale.

When the Hæmodromometer is used, a large artery is exposed for about three inches, and a piece is cut out of it after means have been adopted for the prevention of hemorrhage. The next step is to fix the cone-shaped open cups into the open ends of the artery, and each end of the horizontal metal tube is then fitted into its corresponding cup. I should mention a precaution which it is here necessary to observe—it is this: to so arrange the distance of the cups that, when the horizontal tube is introduced between them, the *continuation of the vessels* is as little altered as possible by the intervening mechanism. The blood now continues to circulate through the horizontal tube as it would were the vessel entire, the stopcock being so turned as to shut off communication with the glass tube. This latter is now filled with water, and is fixed to the horizontal tube by means of pipes. The arrangement is now complete, and the stopcock is turned, so as to shut off the *direct* communication between the two ends of the horizontal tube. The blood now enters the glass tube, and pushes the water before it into the peripheral blood vessels, with (according to Volkman) only a very slight admixture between the two fluids.

I have now described at length this very ingenious instrument; and it would seem at first that it supplies what is needful, in every respect, and that the results obtainable from experiments with it are very reliable. On mature consideration, however, no one will fail to perceive that there *are* grave objections to it; and it now devolves upon me to mention those which have struck me as being most prominent. There are one or two of these objections which I myself have not succeeded in obviating; and many will say that it were well that I should pass over these, and confine myself to such as I *can* remove. Were I to heed such suggestions, I should not be performing the duty I have taken on myself; for, although the instrument which I am about to describe I believe to have many advantages over that of my brother physiologist, no one is more sensible of the fact than I am that it is by no means a perfect instrument, and that it is itself open to great objections—objections which I do not despair of being able to remove at some future period, or which, I myself being incompetent, will I doubt not be done away with, and that right speedily, through the exertions of the learned physicists and physiologists to whose notice I submit them. Thus, in mentioning objections to Volkman's Hæmodromometer which baffle my own inventive faculties to remove, I anticipate the defects of my own instrument.

The first objection which I have to state to Volkman's Hæmodromometer is applicable to mine also—it is that of *the sudden propulsion of the blood from a tube of elastic and contractile force into one perfectly inelastic, and one not having muscular force.* The effect of this condition is more serious than is generally imagined; for when the natural calibre of the *artery,* or its caliber *when not in the distended state,* corresponds with that of the *glass tube,* the former is capable of receiving a greater quantity of blood than the latter; and the contractility called into action by this expansion is now exerted, and contributes to quicken the velocity of the remaining fluid. No such conditions as these exist in the glass tubing; and the only plan I have adopted, with a view to lessen this difference between the two tubes, is to use a glass tube whose caliber will be equal to that of the artery when at a moderate expansion.

The second objection is one which, although I have considerably lightened, I have not been able entirely to meet, namely, the *existence of sharp turns in the long glass index tube.* In Volkman's instrument there are three of these sharp turns; one at the entrance, and another at the exit, both of which are right-angled; the third is situated in the centre of the tube, and is in reality made up of two turns, each of which is right-angled also; the *effect* is alleviated in the latter case by the curves being well directed; but in the former cases, namely, at entrance and exit, the arrangement is directly angular. I need not say how detrimental to the velocity of a running fluid the presence of these angles is, nor need I explain how the column of blood which is being propelled into the tube, meeting at its entrance an opposing wall has to be reflected, as it were, from it before it pursues its course. The same takes place at the exit of the tube, except that here the reflection, if I may be allowed the term, takes place in an opposite direction; so that, instead of the fluid being prevented to a degree from entering the tube, it is here hindered in leaving it—not *altogether,* of course, but in a degree to affect considerably the velocity of the movement of the contained fluid. At the centre of the tube, also, is a sharp turn, arranged so that the fluid arriving by one limb of the tube has to be sent back immediately after moving round this sharp double turn in the opposite direction. My instrument must be regarded as of much better design in respect to *curves in the tube* than that of Volkman; for, while the fluid entering into his is immediately sent in a direction at right angles to the course, the direct course of mine is interrupted but very little. The curves in my Hæmodrometer are greatly exaggerated, and the caliber of the tube where they exist is slightly increased.

The third objection which I would urge is *the sudden propulsion of hot blood from a vessel of a certain temperature into another of a much lower degree of heat, or almost cold.* This defect would seem to be of such trivial consequence as to warrant its being entirely overlooked. The experiments which I have made touching this question, however, induce me to insist on the above as a decided objection. I have seen that when blood or any other fluid is heated to a certain point, and is passed through a vessel of a certain temperature, and when, after traversing this tube for a certain distance, it is then made to pass through another tube continuous with the first, but cooled to or below zero, the velocity of the running fluid is diminished from that which was maintained in the heated tube. The manner in which I have sought to remedy this evil is the following:—The flat support, to which is attached the essential part of the instrument, is made so as to contain two moveable iron heaters; when these are removed, and heated, and then sent home into their respective cavities, the warmth they contain is communicated first to the copper support, and thence to the glass tube, through which the blood courses.

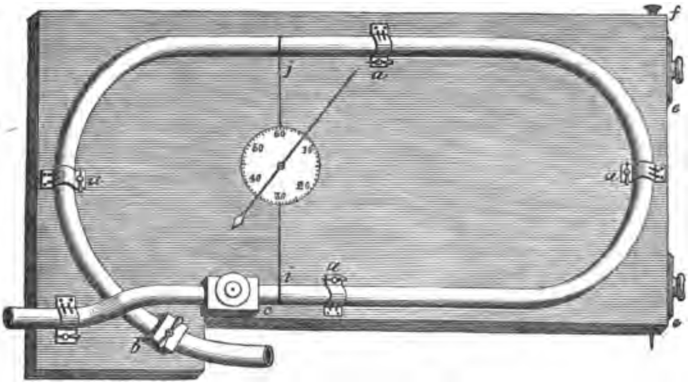
The next objection refers rather to the mode of using the Hæmodromometer than to the instrument itself. Volkman's apparatus was, you will remember, filled with *water* previously to operating. Now, no one will refuse to recognise the inadvisability of the blood having to meet a fluid of a very different specific gravity from itself, and one, moreover, whose total immobility it has to overcome ere it can itself move an inch. I look upon this as a most serious objection to Volkman's mode of estimating the velocity of movement of fluid in a tube; and indeed Volkman himself would seem to have anticipated that the validity of his method would be called into question on this account, since he takes care to inform us that the water is moved into the peripheral arteries with but little admixture with the blood. I can only say that I have put Volkman's statement to the test of *experiment*, the most reliable criterion, and I have invariably found the mixture of the two fluids to be most considerable, and the specific gravity of the resulting mixture to vary much from that of either the blood or water. When using my instrument, I apply one end of the tube to the cut end of the artery whence the blood flows, and I apply suction at the other end, so as to create a vacuum, into which the flood flows freely. When it has arrived at the opposite end, having turned the stopcock, I remove the ligature which had been placed on the peripheral end of the artery, and introduce the end of the tube into that of the vessel; and the blood flows, on again turning the stopcock, as though it experienced no interruption whatsoever. Of course, these latter operations should be performed as quickly as possible; and, in order to avoid the trouble of tying and untying ligatures, I make use of a minute forceps—one which on pressing with the fingers opens, and on removing the pressure closes with a tight grip.

I have now mentioned the four great objections which I have to Volkman's Hæmodromometer: each one of them *tends to decrease the velocity of the blood's movement; and hence, when we consider the combined effect of these, we must allow that the results of experiments made with this instrument are not such as can be relied upon, nor do they correctly estimate the velocity with which the blood moves in the arteries.*

It now behoves me to describe a Hæmodromometer which I would propose as a substitute for Volkman's; and I must confess that I feel considerable diffidence in so doing, not because I myself doubt for one instant the superiority of my instrument as far as regards accuracy, but since I feel it to be presumptuous in me to offer aught to the scientific world intended to compete with the productions of so learned a physicist and physiologist as Volkman. My duty, however, prompts me not to yield to such feelings; and so, with a firm conviction of its worth, I proceed to the description of my Hæmodromometer. In my description I beg to refer to the diagrams, such as they are, which I have drawn, in order to render the details more intelligible.

The complete instrument, as seen in the drawing (Fig. 1), consists of the copper support, to which is attached, by means of the fasteners (*a, a, a*), the glass index tube, furnished with its arrangements of stop-cock (*b*), and piston (*c*). The free extremities of the glass tube extend slightly beyond the support, so as to be more readily connected with the cut ends of the artery. Near the centre of the support is a chronometer, the hand of which describes the circle in one minute. At one side of the support are represented the heaters (*e*), which are sent home into their respective cavities.

Fig. 1.



The shape and construction of the support will be readily seen on glancing at the diagram. It is made of copper, which is a very good conductor of heat. At its side are the openings of the two cavities, which extend longitudinally along it for about three-fourths of its length; into these cavities run the iron heaters, furnished with handles of porcelain, so as not to burn the hands of the operator when they are to be removed from the fire. The heaters are kept in their position in the support by means of a long iron pin, which runs through a hole in the support and heaters, as seen in the drawing (*f*).

The index tube will be seen to have a peculiar form; and, simple as this form looks, it has cost me much thought and consideration to determine on it as being that which would be least likely to prove detrimental to the flow of fluid in it.

This tube will be observed to have no sudden angles in its course. The fluid on entering into it is *not* met by an opposing wall, as in Volkman's instrument, nor is it immediately turned in a direction at right angles to the one it was previously pursuing; on the contrary, the deviation from the natural course is gradual, and the fluid is coaxed, as it were, round the turns in the tube, when it arrives at them. I have already mentioned that the caliber of the tube equals that of the artery when at a moderate expansion, and also that the caliber of the turns of the tube is very slightly wider than the caliber of the straight portions. I need not again repeat why these differences in caliber should exist. From the foregoing remarks you have already anticipated the necessity for having different tubes, each with a different bore, so as to be applicable in the case of variously-sized arteries. I have described to you Volkman's arrangement of cone-shaped cups for connecting his tube to the ends of the arteries. I do not recognise the necessity for this plan at all; and I believe that, if the glass tube have its termination furnished with slightly raised edges, so as to take a purchase on the artery, the desired effect is obtained just as well.

The removal from or fastening of the different tubes to the support is easily effected by opening and shutting the fasteners (Fig. 1 *e*), which are furnished with hinges and clasps.

Fig. 2.

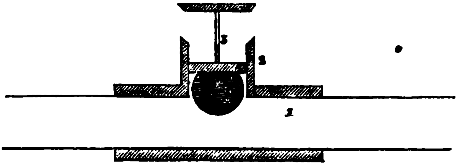


Fig. 3.

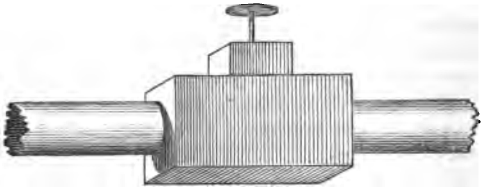
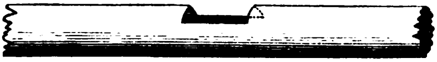
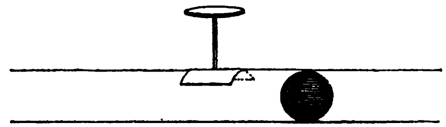


Fig. 4.



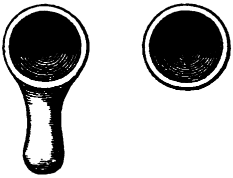
Each tube is furnished with a piston index apparatus (*c*), and with a stopcock (*b*). The piston index apparatus (Figs. 2 and 3), consists of two tubes, the one horizontal, whose bore equals that of the glass tube, and which is continuous with it; the other perpendicular, arising from the centre of the former, and into which fits exactly a piston. This latter tube, instead of being rounded, as is the horizontal tube, is square. Where the two tubes communicate, therefore, a square orifice exists in the upper wall of the horizontal one (Fig. 4); so that, were fluid traversing this latter, it would rush up into the square perpendicular tube. The handle of the piston consists of the stem, the press, and the handle proper. The stem is of such length, that, when the piston is shut down, the press, or lower surface of it, must form a continuous surface with the upper wall of the horizontal tube. In order to effect this continuity of surface, the press (Fig. 5) must be curved correspondingly to the wall of the horizontal tube; and it must be of such size as exactly to fit the piece which is wanting where the two tubes, horizontal and perpendicular, communicate. The whole of this mechanism is constructed of brass. The piston must be removable from its perpendicular square tube, so as to admit of the index ball, which I shall presently describe, being attached to its press. When an observation is to be made, the piston is to be taken out, together with the lid of the perpendicular square tube. To the under surface of the press is then attached lightly the index ball, which is made of gelatine. The arrangement is then placed in the position as seen in the drawing (Fig. 2), and the blood is now brought through the glass tube, the above preparations having been, of course, completed first. When the time has come for making the observation, after the blood has been circulating for a few seconds, the piston is pressed down, the spring which kept it raised is overcome, and another spring is engaged which keeps it down. The index ball is thus suddenly propelled into the current, and, being of a certain size, is carried along the tube with the same velocity as that with which the blood itself moves; the lower end of the press of the piston has at the same time formed the wanting part of the upper wall of the horizontal tube, and the blood courses without interruption. The index ball has not gone far before it comes up to a scratch (Fig. 1, *i*) on the glass index tube. As it passes this point, the operator glances at the chronometer, and notes the time; subsequently, the ball passes another scratch (Fig. 1, *j*), which is at a known distance from the former one, and immediately as it does so, the operator again consults the chronometer, notes the time, and turns the stopcock to prevent the ball from passing into the peripheral end of the artery. The observation is now completed, the index ball having passed through a certain distance in a certain lapse of time, and thus the velocity of the movement of the blood has been computed.

Fig. 5.



For a long time I was puzzled how to obtain balls of such lightness as would not affect the movement of the blood. After some consideration, I adopted the following process:—A warm concentrated watery solution of gelatine is made, and the polished extremity of an iron rod is rolled about in it, having been previously dipped in oil. The rolling having been continued for some seconds, the rod is taken out of the solution, and a thin coating of gelatine adheres to it. This coating has now to be removed from the mould, which is done by very gentle manipulation, until it is coaxed off. A small "exhauster," furnished with a sharp extremity, and with a stopcock, is now introduced into the open mouth of the gelatine ball, and, by working with the fingers, the latter becomes tightly applied to the extremity of the exhauster, and the air is sucked out from the ball by the mouth. When it is considered that nearly all the air has been subtracted, the stopcock is turned before taking the exhauster from the mouth, and while the suction is yet going on; a little careful manipulation is now required to remove the ball from the exhauster without allowing the air to re-enter. When the operator has succeeded thus far in the manufacture of his ball, the next step is to make it as round as possible. This is effected by two "rounders" (Figs. 6 and 7), which I have sketched; these consist of polished metal; they are hollowed out slightly from centre to surface; one of them is furnished with a handle, and the other is to be laid on the table when using them. They are first heated by pouring some warm oil on the polished hollowed surface; the index ball is put on the one which is stationary, and the other "rounder" is *gently* worked over it in a circular manner until the ball has become perfectly round; the rounders are heated at intervals by adding more hot oil to their polished surfaces. I need not mention the necessity there is for iron moulds of *different* bulk, in order to produce balls of different sizes, adapted to the variously sized tubes.

Figs. 6 and 7.



I have now completed the description of my Hæmodromometer. That I do not expect it to be considered as anything like a perfect instrument, I have already said. I know that some physiologists will object to it on account of the complexity of previous operations which must be performed when working with it; but will any one, I ask, give the preference to Volkman's instrument simply because of the trouble of working which mine would cost the operator? If so—if it is desirable that instruments be made with a view rather to save the operator work, than to attain to accuracy of result—then have I laboured in vain.

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XXXIV.—ON THE HERRING FISHERIES OF IRELAND. BY WILLIAM ANDREWS, M. R. I. A., Chairman of the Natural History and Museum Department, Royal Dublin Society; Vice-President of the Royal Geological Society of Ireland, and of the Natural History Society of Dublin, &c.

[Read before the Royal Dublin Society, February 19, 1866.]

THE discussions on the Fisheries at two meetings of the Society, held the last month, presented such differences of opinion with regard to their importance on the coast of Ireland, and their modes of development, especially with reference to the Herring Fishery, that I have been requested to place before the Society the views that I have entertained and confirmed, and which appear to some extent to have been misinterpreted in the limited explanation that was afforded at those meetings.

The paper by Mr. John Hoare gave full statistics of the value that their present mercantile importance has attained, and which the facilities of his business transactions enabled him with some accuracy to put before you.

The present paper will be confined to the Herring Fishery of this country, its great importance, and to observations on the character, seasons, and habits of those fish on the Irish coasts. I shall not enter into the early history of the fisheries, or of the laws that regulated them previous to the Union, but merely refer to that period when their decline became alarming, and which led to the adoption by the Imperial Legislature of more vigorous enactments for their encouragement.

By the Act of 1819 bounties were granted on the produce of the fisheries, and subsequent renewal of Acts greatly stimulated them, until all bounties were finally withdrawn in 1830. Inspectors-General were appointed for each province, and their reports, chiefly those on the fisheries of the coasts of Ireland for the year 1820, plainly indicated how they were controlled.

By the 59th Geo. III., a bounty of £3 per ton was awarded on the tonnage of all vessels fitted out for the deep sea Herring Fishery; and we find by those reports that a brig of 78 tons, and sloops of 67 to 55 tons, were fitted out, and were claimants for such bounty. The Act of 1st of Geo. IV., cap. 82, made alterations with regard to the adaptation of vessels, the gear necessary for them, their equipment, and further prescribed modes of fishing. This encouraged a host of adventurers, who, no doubt, aided by such bounties, were enabled to obtain without loss to their enterprise large stocks of cured fish, which were sold at moderate rates, and which greatly benefited the markets and the population of those places to which such supplies were brought.

In 1824 an abatement on the tonnage bounty for the herring fishery was made; for, instead of £3 per ton, the bounty was reduced to £2 per ton, and £1 per ton was allocated on the cod and ling fishery in the taking and curing. From that date all bounties were gradually reduced, until by the 7th Geo. IV., cap. 47, they ceased on the 5th April, 1830.

It is singular to remark the changes that were effected by those laws on the Irish coasts. In 1819 there were only 27 vessels and 188 men returned as employed in the Irish fisheries. In 1823 there were 27,142 vessels and boats, employing 49,448 men; and from 1824, when the bounties were gradually withdrawn, to 1830 the number of vessels had decreased, while the number of fishermen had increased. In 1829 the number of vessels engaged was 12,611, while the men and boys employed numbered 63,421. The bounties paid a tonnage on all kinds of cured fish, which for the ten years of bounty amounted to £151,390 4*s.* 7½*d.* It is not to be wondered at that those bounties greatly advanced the fisheries of the country; for large and well fitted-out wherries went annually to the west and north-west coasts—from Skerries, Rush and Balbriggan—prosecuting vigorously the deep sea cod and ling fishery, and also purchasing from the fishermen of the coasts large quantities of herrings, which they cured in bulk, the vessels being provided with salt and other necessary stores.

The withdrawal of the bounties greatly affected the fisheries; for the number of large boats rapidly decreased, being principally owned by tradesmen and adventurers, which thus threw a large body of fishermen into distress, and deprived them of employment. Still, however, there were enterprising factors, who annually fitted out vessels for the purchase of herrings around the coasts, especially the winter fish; and the wherries and smacks of Skerries and Rush occasionally made their north-west visits for cod to Boffin, and even to Iceland, and still prosecuted the Herring Fishery, partly by fishing, and by purchasing from the native boats at Killybegs, Galway, and Bantry. It was not surprising that the bounties were withdrawn; for their application had been so frequently misappropriated, and both bounties and loans made applicable to purposes foreign to the objects desired, that their suspension was justly decided on, as removing a very fallacious mode of conferring any permanent benefit.

From this period, each year the Herring Fisheries and the ling and the cod fisheries declined, and succeeded by those sad years of famine and of cholera, almost annihilated our coast population, and forced us to be chiefly dependent upon Scotland for those supplies. Emigration greatly worked out the decline; for although in such harbours as Skerries, the fishermen were numerous, and seamen the best on the coast, and although their wherries and smacks were employed as carriers and traders, yet, that employment not being permanent throughout the year, many annually emigrated to America.

Similarly, in Scotland, under the same act, the 7th Geo. IV., cap. 34, all bounties ceased on 5th April, 1830, the bounties on herrings being gradually withdrawn to that date. For eleven years previous to 1826 the bounty on herrings cured, gutted, was 4*s.* per barrel; and for the four years to 5th of April, 1830, the bounty was reduced to 1*s.* per barrel. That act, however, did not affect the establishment of the Board in Scotland, nor the annual grant made for its support, as the Act of 1808, 48th Geo. III., cap. 110, was made perpetual by a subsequent Act, 55th Geo. III., cap. 94, which constituted the inspecting and branding of fish, and which continued after all other bounties had ceased. By the 5th Geo. IV., cap. 64, a grant of £3000 a year was continued to Scotland in lieu of so much of the grant for tonnage bounties made under the Act of 1808; and that sum is drawn to the present day by Scotland.

This Act (5th Geo. IV.) also confirmed the Act of 59th Geo. III., cap. 109, which allocated to Ireland £5000 per annum, Irish, for similar purposes; and these grants to both countries continued after all bounties had ceased, and do still continue in full force.

On the nature of the grant to Ireland I shall hereafter make some comments. It is reasonable to inquire what caused the rapid decline of the Irish fisheries after the cessation of bounties; while Scotland, on the other hand, seemed each year advancing, and increasing in the number of boats and men engaged in the fisheries, not only supplying its own immediate wants, but largely exporting to Continental markets, as well as to Ireland. By some authorities the capriciousness of the herring on our coasts is said to have been the main attributable cause; by others, the indolence and want of industry of our fishermen; and many have averred that the fisheries on the coasts of Ireland are so fickle and uncertain as to have led to the utter failure of all attempts at their development. Not any of those surmises—for they are but surmises—bear the slightest foundation of truth. What, may I ask, has for the last half century brought annually the boats of Penzance and of St. Ives to visit Ardglass, Howth, and Kingstown, and to remain until the pilchard fishery of their own shores caused their return—what the Campbeltown and the Manx boats, were it not that remuneration each year compensated their summer ventures to the Irish coast? No; their success was consequent on the superior equipment of their boats; their long and deep trains of nets, of superior make and fineness; and, above all, their superior judgment and experience in seeking the early summer fish in the deep water, and detecting the influences of winds and of currents that affect the changes of the course of the fish during the several seasons. To these may be added the facilities of a ready market for the fresh fish. It was owing to the want of these means that even in 1861 there were but four boats fitted out at Howth for the fishery, which caused the stranger fleet to be attended by a number of carrier smacks. Although Arklow men were by no means incapable of coping in industry and perseverance, and though much improved in nets, their boats were not of sufficient tonnage; and thus the Skerries, the Rush, and the Balbriggan boats, once so famous on the north-west coasts as deep-sea line fishers, had chiefly become buyers of fish, as well as carriers of potatoes and of manure.

For some time after the bounties ceased, the Skerries boats still continued to visit the coast of Donegal, generally being at Killybegs about Christmas to purchase the winter herrings. These boats averaged 45 tons, stowed each about 14 tons of salt, and carried a boat on deck for shooting nets; and the quantity of fish taken may be estimated, when, with but indifferent nets, and the native boats from which they purchased fish being but three tons, with only four oars, a wherry was enabled to complete a cargo of 200,000 herrings, cured in bulk, for sale in different markets. These enterprises at last altogether ceased; and, when the coasts were almost depopulated of fishermen, the boats and the nets wretched and inferior, and wholly unsuited to the deep water, then it was said that the Irish fisheries had declined, and were unproductive. Still there are many of the smacks employed as carriers, and buying fish from the fishermen for the home markets.

Brighter scenes, however, have now chased away those erroneous views; and the men of Howth, Skerries, Balbriggan, and Arklow can vie with the ablest of the Cornish and Scottish craft. By assistance given to many of the fishermen, it has been shown that the fishermen of the east coast can compete in seamanship and industry with the best of their annual visitants. Along a great part of the east coast fine boats are now fitting out for the Herring Fishery; Howth, Sketries, and Balbriggan taking the lead in the superiority of vessels. At Skerries alone there are 116 smacks and luggers; 42 luggers, averaging 30 tons each, fitting out, with full complement of herring nets, where but a few years since not a single craft was so engaged. For the coming season fine luggers, both at Howth and at Balbriggan, are preparing for the mackerel season off the south coast, and the same may be said of Kinsale.

Great assistance has been given by loans through the Society for Bettering the Condition of the Poor of Ireland; for the Society has advanced to the extent of £3000 in the year, free of interest, and repayable by easy instalments. An intelligent and enterprising man at Balbriggan assured me that he had made thirty per cent. on the loan he had obtained.

The capriciousness of the Herring Fishery has often been urged by those who are ignorant of the true habits of the fish, as decidedly unfavourable to the investment of capital in such a branch of industry. Some writers still maintain a migratory disposition of the herring; and state that bays and estuaries, which they once frequented in abundance, are now completely deserted. The Cornishmen have often remarked that there does not appear any diminution of the fish off the coast, but that frequently a good night is succeeded by an unsuccessful one, and then the herrings appear plentiful again. This is all attributable, as I have before said, to the good or the bad position of the boats, when weather or other causes have influenced the great body of the fish to change the direction of their course, and which is constantly varying in the deep water, until the maturity of spawning forces their closer approach to the shore. The herring is a deep-water species, remaining throughout the year off the coasts of its birth; hence it is that, in the Clupeadæ, as well as in other genera of our marine fish, locality, soundings, and distribution on our coasts, more or less affect superiority of quality of the same species. The herring is abundant around the entire coasts of Ireland. The small and unsuitable boats, and the limited length and depth of nets, prevent the herring being sought at those parts of the Bays of Donegal, Galway, Dingle, Kenmare, and Bantry, where the fish in the early part of the season are to be met in abundance, and of a quality not inferior to first-class fish of the Scottish lochs. It is superiority of tonnage and equipment that occasionally gives such enormous returns to the Yarmouth, Sussex, and east coast boats that fish far from the land, and that supply the English markets with the earliest and primest fish; and even the Cornish boats that visit our coast in the summer are during the spring months employed in mackerel fishing, from S.S.W. of the Lizard to within a few leagues of the French shore. Our men of Howth and other parts of the east coast are now adding both to the tonnage and equipment of their boats, and each year with greater profit in their pursuits; for they now successfully, in the mackerel season, brave the heavy weather off the south coast. I have frequently, in early summer, off the Shannon, and off Dingle and Tralee Bays, seen the herring in extensive shoals, when not a fish had entered those estuaries. In the month of June, off the Arran Islands, Galway Bay, I passed through such masses of mackerel and herring of a fine night, that handnets full could have been lifted into the hooker, and yet no fish were captured by the Claddagh boats until the latter part of the summer, when the fish moved up the bay within Blackhead.

To accomplish great success, ample means must be employed; and with a knowledge of the coasts, and of the habits and seasons of fish, capital so employed is as sure of return as any other mercantile speculation. During a month of last season the Yarmouth fishing boats alone caught 25,000,000 herrings, valued at £30,000. The value of a seine in the pilchard fishery, with boats and grapnels, is said to be £15,000. Seven seines, joined, took, on the Cornish coast, in one haul, pilchards to the extent of £25,000, which were cured for the Mediterranean. During 1865, St. Ives sent to Mediterranean ports pilchards which realized £23,647 10*s*. Forty-eight thousand barrels of fresh herrings of 700 each, 265,000 baskets of bloaters, of 150 per basket, and 60,000,000 of red herrings, are annually consumed in London.

The quality of the Irish herring has often been commented on, and by many of experience stated as superior to fish of the best condition of the Scottish coasts. There can be no doubt of the truth of this, but not in the present state of the Irish fisheries. The quality of the herring depends upon the season and mode of capture, and upon the superior system of its cure. It is that that has rendered the Loch Fyne herring of such standard quality—its early capture in the primest season. Since the last meeting of the Society some Loch Fyne herrings were sent to me, which for delicacy of flavour and quality could scarcely be equalled; the roe and the milt were but partially developed. I was informed that many of the lochs north of Loch Fyne had herrings fully equal in quality, such as Loch Eribol, and that they are often sold in Glasgow as Loch Fyne, and the very best judges cannot detect the difference. Such would be the case with the Arklow and Howth herrings, if carefully handled when taken from the nets, and a proper system of cure attended to. On other parts of the coast of Ireland, where herrings are abundant and of fine quality, their superiority is altogether lost by the modes of capture, and lateness of the season when taken.

I come to an important part of the life of the herring—the periods and the habits of spawning. Few are the writers on ichthyology that have given proper attention, or indeed had the opportunity of tracing the career of the herring throughout the seasons. Even John Mitchell, of Leith, who in 1864 published voluminous statistics of the herring, had not correct knowledge of its true habits. I had intended criticizing the remarks he had made on the Fisheries of Ireland, but *mortuo verba nunc facio.*

It has long been known to practical fishermen on the coasts of Ireland that there are two seasons of the herring in the year—the summer or harvest herring, and the winter herring. In many bays on the western coasts, such as Donegal, Galway, and Bantry, the winter fishing was a great profit to the native fishermen, as boats from the eastern coast frequented those bays to purchase, and to cure in bulk for different markets. This trade has nearly ceased, owing to the wretched condition of the coast fishermen, and their want of boats and nets capable of supplying to purchasers the quantity required. Herrings can be taken on the coast at all seasons of the year, but their condition varies much with the several seasons. In May the summer herrings begin to move from the deep water; in June they appear in large and compact shoals; in July and August they approach nearer the land in great bodies; and in September and October perfect and complete their spawning conditions. During the month of October fine fish may be taken, but still they are mixed with spent or shotten fish. During November, although quantities may still be taken, yet they are spent and insipid fish, generally mixed with numbers of fish of an inferior size that have not spawned. In December they have mostly returned to deep water. The winter herring fishing begins early in January, and terminates the middle of February, when those fish begin to spawn, and continue so during the month of March. From the middle of February to the middle of April the herring is unhealthy and insipid. Such are the seasons of the summer and winter fish. The summer herrings are richer, and more delicate in quality; the winter fish, superior in size, but coarser. The fish that have not spawned during the autumn are those at that time of inferior size; but, rapidly increasing in development, spawn in the spring.

Some years since, in the month of September, when on a visit at the hospitable Castle of Derryquin, in the harbour of Sneem, Kenmare Bay, large quantities of herrings were taken. The harbours of Sneem, Kilmachalogue, and Ardgroom, were alive with fish. Several fine nights I visited the little herring fleet, which, inside the harbour, with their shallow nets, were taking the fish in abundance. The fish were fine, and in full maturity of spawning. During a south-west breeze the fish were seen rushing in bodies in every part of the harbour, and so numerously, that from the rocky ledges and at the shores they were taken by handnets and baskets. I carefully watched their movements, and found it was the full excitement of spawning. The fish were densely pressing upon each other in every part of the harbour. Those that were taken had ejected both ova and milt, which agglutinized together, and, being of heavier specific gravity than the water, sank to the bottom, and became attached to stones, seaweed, or to any substance met in descent. Thus, in every part of our coast, in the shoaler bays or inlets, the instinct of the herring at the full maturity of spawning incites its approach to deposit its spawn. In the month of October, the "Galway Express" mentions that near 400,000 fish were brought into market in one day, all captured about the pier, and far up in the inlet of Oranmore.

It is mentioned that, in a little bay east of Cromarty, such an immense shoal was thrown, or rather ran themselves ashore, that salt and casks failed the packers. Similar is the instinct that excites the capelin (*Mallotus arcticus*). These little fish crowd into the shores of Newfoundland and Labrador in July, in countless myriads, to spawn. In the bays every rolling wave strews the shore with hundreds of capelin, which are washed off by the retiring wave, all leaping and pressing together in the act of depositing spawn, the compression excluding the ova. The ova become attached among fuci and confervæ.

From the views I have given of the spawning seasons of the herring, it is clear that, should a close season be essential, that prohibition should be exercised for November and December, and from the middle of February to the middle of April. At those periods the fish are soft, insipid, and not suitable for curing.

Having so far endeavoured to condense a subject so extensive as the state of the fisheries and the habits of the herring, I now turn to its mercantile importance. Within these few years the capture of the herring has been so successful to the boats of our fishermen of the east coast of Ireland, that the branding system has been agitated, and regarded by many as essentially necessary to still further promote the industry of the country, and to secure to it some portion of the benefit that Scotland is considered so largely to derive from it. The brand is the relic of the old bounty system, granted and continued to Scotland in lieu of tonnage bounties, and in connexion with other grants that are still in force in that country. Although, under the inspection directed by the Board of Fisheries of Scotland, a notice of all fish cured must be given to the inspecting officer, yet it is not compulsory on the curers to have the brand. The returns, therefore, show that nearly the whole of the western parts of Scotland reject the brand, the use of which appears only general to the eastern parts of the coast, and to Stornoway, Shetland, and the Orkney Isles. The Continental agents or merchants at the ports, to whom are consigned the large exports from Scotland, feel confidence in the official brand, when marked as Crown full, Crown P., Crown PP., or as Maties; and which, without examination, facilitated their disposal in the inland markets. Deceptions have been consequent, and many consider it far better to abolish the brand altogether, and to depend upon the reputation of the curer, whose trademark would be ample security for the purity and value of his consignment. Is not the XX of Guinness, the LL of Kinahan, and the name of Jameson, such as to secure the reputation of their exports to all countries? If we confined ourselves to such examples, no doubt the reputation and quality of the Irish fish would eventually be justly esteemed wherever exported to. Still, so long as the brand is of utility to Scotland, it is but just that she should continue to maintain that right, and those grants that have been drawn by her for years for the encouragement and the protection of her fisheries.

But, on the other hand, Ireland should also receive her share. No brand favours the industry of Irish produce, and she has even been denied for years that grant of £5000, which she annually should have received under the very same Act of Parliament under which £3000 a year to this day has been drawn by Scotland.*

It may be argued, what has Ireland to do with a brand? Look at the present imports, between 70,000 and 80,000 barrels of herrings required by her from Scotland each year, chiefly from Wick, Stornoway, and the Orkney Isles, and to these may be added supplies from Norway. Large imports also are made of ling and cod, and Newfoundland fish.

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* Referring to the Report from the Select Committee on the Taxation of Ireland, ordered by the House of Commons to be printed 1st June, 1865, at page xxxix will be found the amendment proposed by Sir Edward Grogan, which fully details the several Acts of Parliament bearing upon this important question. The whole of the fishery laws *with regard to bounties*, and the duties of the Commissioners appointed under the Act of 1819, ceased by the Act of 7th Geo. IV., c. 47, on the 5th April, 1830; the Act of 7th Geo. IV., c. 34, sec. 4, merely superseded those portions of the Acts 59th Geo. III., cap. 109, 1st Geo. IV., c. 82, 1st Geo. IV., c. 103, which related to bounties, and which were to be discontinued on the 5th of April, 1830. The Act 1st William IV., c. 54, sec. 8, has been viewed as repealing Act 59th Geo. III., c. 109, but which seems to have been misinterpreted with reference to that section which quotes the annual grant of £5000. The Commissioners of Fisheries appointed under the Act of 1819 terminated their duties when the bounties ceased, and it was necessary that the construction of piers and harbours, undertaken by said Commissioners previous to 5th April, 1830, should be completed. Grants to the extent of £13,000 were sanctioned by the above Act to the Directors of Inland Navigation for that purpose. These grants did not affect the discontinuance of that £5000 a year, which, under sections 9 and 10 of 5th Geo. IV., c. 64, still continued in force in Ireland; and which the Act of 5th and 6th Victoria, c. 106, sec. 1, fully confirmed.

Yet even these supplies were short of the demand during the Lent of last year. Are not, then, these strong grounds to seek those rights for the encouragement of our fisheries, and to induce capital to be expended in the obtaining and securing to ourselves those stores that are inexhaustible on our coasts? It is seen that the takes of fish both at Ardglass and at Arklow, in the early part of last summer, were great; and that the continuation of the takes was large that were throughout the summer brought to Howth. The demand for the English market, and for fresh fish, left but little surplus; for it was only when the late day sales, or the price per mease was lowered, that limited purchases were attainable by the home curers. Had Scotland the same facilities for the transit of her fresh fish that we possess, the curing for foreign markets would be greatly limited. Two-thirds of the fish barrelled and sent from Loch Fyne are but slightly salted, and are sold as fresh in the home markets. The facilities of transit in Ireland are now great, while the resources all around our coast are almost untouched. We require capital; we require large boats, and these prudently managed and disposed with judgment; and with a knowledge of the seasons of fish, and of the habits of the fishermen, no mercantile speculation would be more remunerative. The cattle plague has struck terror into the British Isles; a scarcity of provisions is threatened, and yet upon what resources could we so securely depend as upon our fisheries? See the returns for the investment of capital. Scotch barrelled herrings at present realize 40*s.* per barrel, ling 34*s.* to 36*s.* per cwt., or 4½*d.* per lb., and all other fish scarce and high in proportion. But we want large boats; and this will lead to another object of great importance, and one strongly demanding the attention of the Imperial Legislature—viz., the harbours of our coasts.

To the kindness of my esteemed friend, Charles Haliday, Esq., of Monkstown Park, I am indebted for references to his extensive and valuable collection of records and reports of the past and present history of the state and condition of this country; and he kindly placed at my disposal a collection of charts of the entire surveys of the Irish coasts, as well as all records and Acts of Parliament bearing upon the subject that I have been so much interested in. The original plans of the piers and harbours designed by the late Alexander Nimmo, C. E., and the surveys and soundings made in 1821 and 1822, under the directions of the Commissioners of Fisheries, as well as charts of the harbours of the east coast, dated more than one hundred years since, I have carefully examined. These, however, give no useful views beyond the test of the soundings of those dates and recent surveys; but they convey very satisfactory evidence of the alteration of depths of soundings by silting or other causes. Nimmo's piers were but indifferently constructed; and, being mostly tidal, were only suited to the small hookers, yawls, and corrachs then in use on the coasts. The few hundred pounds allocated for their formation did not afford proper durability in their structure. The winter storms have mostly cleared the work.

Along our eastern coast, where our fisheries have most progressed, our harbours are tidal, and inadequate to contain the boats that assemble for the fishing. From Kingstown south to Wexford, or north to Ardglass, where have the boats to run in heavy weather? The best position I see on that coast is that of Skerries. The fishing grounds lie chiefly to the north-east of the Rockabill; and even Ardglass, that has some depth of water, is not so convenient as a general position as Skerries. But Skerries is a tidal harbour. The large class of boats now belonging to Skerries, to Rush, and Balbriggan, have no place of refuge in a breeze of wind, nor to work out to the fishing grounds at all times in suitable weather. They must lie hauled up for the winter, or sheltered in the creek of Baldoyle.

The pier of Skerries runs in a northern direction 650 feet, having a depth of water at its extremity of fifteen feet at high tides. The springs, full and change, rise fourteen feet, but the harbour within dries at low water. By an old chart, 1765, no silting appears to have affected the soundings. Parts of the harbour appear greatly changed, and the anchorage much injured by ballast being discharged by the Wicklow boats that go there for limestone. It is stated that occasionally 150 tons a week have been so discharged during the last twenty years, and even in reports of 1835 the evil of this practice is particularly alluded to. The clearing of that harbour should be enforced, and the present injurious custom checked.

I have alluded to a grant of £5000 a year, Irish currency, and which is still in force, and mainly applicable to harbours and fishery piers. This sum has been unappropriated for the last thirty-five years. Skerries is a position for the allocation of such moneys; and were the soundings cleared in the harbour, and a breakwater pier extended along the rocks of the cross which project seaward 750 yards, having a wide basement and firm foundation, and by giving a slight elbow or curve at the extremity, deep water would at all times of tide be inside, and would afford ample shelter for all classes of vessels that frequent that part of the coast. In the furtherance of such plans the Commissioners of Fisheries, in the Report for 1821, refer to the importance of the aid, through the Royal Dublin Society, by a statistical survey of the coasts. It would be the means of greatly encouraging the building of a large class of boats, and of giving employment in the fisheries throughout the winter to the men of Skerries, Balbriggan, and of Rush, and thus retaining a fine body of fishermen and seamen in the country that otherwise are forced to leave their homes, and which also tend to their directing attention to other pursuits than the sea.

The Scotch Board of Fisheries has been for years sensible of the importance of improving the fishery harbours and piers. In addition to Government grants, large outlays have been made by the British Fisheries Society for the improvement of the harbours on the east coast of Caithness; and now that society has promoted the formation of a splendid harbour on that coast, to the extent of an expenditure of £120,000. Such attention should seriously be directed to our shores; for, until we have safe positions for our large boats, our fisheries will still remain much crippled. The advantages from the accomplishment of such improvements will be great—the retaining on our coasts, and the employment throughout the year, of a fine body of seamen, and the training with a certainty of a livelihood at their own homes the sons of the fishermen. See the benefit that may accrue to our merchant marine, that at present are forced to man their ships to a great extent with foreign seamen—the sad and melancholy results of which are too often detailed.

The utility of training ships would be thus desirable in certain positions of our coasts, which would stimulate and promote a desire for the sea, and those vessels would be essentially serviceable in maintaining an orderly state among the fishermen in their pursuits. The violent aggressions of the Claddaghmen have often been recorded, not only exercised by them against strangers, but against their neighbours of the bay who they considered infringed their rules. They exacted all monopoly, and regulated the markets, preventing an excess of supply through the exertions of the more industrious fishermen. The Report of the Commissioners of Fisheries for 1820 mentions the necessity of "The Plumper" Gun-brig being sent there, which so awed those lawmakers that the supplies of fish exceeded all expectation. Three hundred boats daily lined the quays, each containing 10,000 to 20,000 herrings. Vessels were laden for other markets, and all the inland parts were most abundantly supplied with the cheapest food. At that period herrings were cured in bulk to an extent of 4000 barrels, of 700 fish to the barrel, while now nearly that quantity of Scotch barrelled herrings are annually imported by Galway.

In conclusion, I cannot avoid commenting upon the views recommended in the Report of the Commissioners appointed to inquire into the Sea Fisheries of the United Kingdom. In the limited opportunity afforded them of the examination of the state of the fisheries of this country, they certainly appear to have advocated an extent of freedom and removal of restrictions by no means calculated to improve their condition. Legislative control and restriction are absolutely a necessity as regards this country. Although I have supported the utility in every sense of deep-sea trawling, yet I have always maintained that, within certain limits of soundings, a prohibition should be observed against all classes of trawl boats, and injurious shore netting, that have always proved destructive to the fry of all kinds of fish. The Acts of 5th and 6th Vict., cap. 106, and 11th and 12th, cap. 92, placed the control of the fisheries in a public board, and gave to it powers with regard to the regulating of our sea fisheries, which, if maintained in all the integrity of their principles, must of a certainty be productive of advantage and protection. Still, I must agree with the Commissioners, who observe in the Report that the Acts "might, in the hands of injudicious and meddling administrators, become sources of much injury to the fisheries, and of the most vexatious interference with fishermen."

I trust that our Irish Members of Parliament will band together, and maintain to us our rights and our laws, so essentially necessary, and by which alone we can hope to foster, to advance, and to protect our fisheries.

I will finish in the words of the eloquent Right Hon. Frederick Shaw, expressed at a dinner given by my esteemed friend the late John D'Arcy, when Lord Mayor of Dublin—"I cannot believe that Ireland, for whom God and nature have done so much, and man so little, with all her great capabilities, and her yet undeveloped resources, is not to have her day. We must all feel and deplore that we have already had a long, dark, and dreary night; but I trust that we discern streaks of a more promising morn—that Ireland will cease to be a byeword among nations, and that she will become an honoured, and, as I believe she ever must be, an integral portion of the United Kingdom."

Mr. BARRINGTON, T. C., ex-Lord Mayor, referred in a complimentary manner to the ability with which the subject was treated by Mr. Andrews, and said he would add nothing more to what had been stated than to draw attention to the young company for the promotion of fishing interests in Ireland. He also referred to the fact that the £5,000 a year formerly granted by the Government for the improvement of Irish fisheries, and which of late years had been discontinued, would now, if paid up, amount to £200,000, with compound interest. He thought the Government should be called upon to pay it up, if there was any chance of their doing so.

Mr. JAMES HAUGHTON, J. P., thought that the first thing the Government ought to do would be to provide proper harbours for shipping; and, having gone so far, they should endeavour to establish the most perfect system of free trade in every branch of business.

Mr. ROPER (Barrister) spoke on the importance of asking from the Government money for the purpose of developing the resources of the fisheries of the coasts of Ireland, particularly as he thought it was a favourable time for asking with a chance of being listened to. If some of the statistics, such as Mr. Andrews had furnished, were given to some of the Irish representatives, the screw might be put on the Governors at the other side of the Channel with benefit to Ireland.

Mr. WALSH (Agent for Lloyd's) said, that the Society should feel indebted to Mr. Andrews for the very valuable and interesting paper just read on the subject of our fisheries; so clearly pointing out the difficulties under which the poor fisherman labours, and the reasons why our truly valuable fishing grounds have not been more fully developed, although they offer such a field for profitable investment. Mr. Andrews has entered so much in detail into the subject, and has so ably described the causes of this backwardness of the fishery interests, that he has left little for others to say beyond reiterating what he has already so clearly laid before you. An acquaintance of many years' standing with the several fishing towns and villages along the east coast, from Balbriggan to Courtown, enables me to bear testimony to the accuracy of Mr. Andrews' view, that one cause of this backwardness is the inability of the fishermen to provide suitable fishing tackle and boats at the proper season. In this, however, I am glad to say, I have recently observed a decided improvement, which I trust may continue. But of another cause, alluded to by Mr. Andrews, I cannot speak so hopefully; I allude to the want of good piers and safe harbours near their dwellings, to which the fishermen might bring their boats. I cannot point to a single pier or harbour on the east coast which meets the requirements of the fishing interests. Balbriggan harbour is not available, but at high water, or near it. Skerries harbour, where the natural advantages are great, presenting striking facilities, not only for a fishing harbour, but even for a Channel safety harbour, has been sadly neglected, and permitted to go to decay; the boats frequenting it to load limestone having been permitted to throw their ballast overboard, even inside the harbour. Howth, after the enormous outlay therein, has been allowed to silt up to such an extent, that the authorities have been obliged to send a dredging machine to clear out the entrance, and remove some of the accumulated silt which fills the harbour; and at Arklow, where the Hibernian Mining Company have spent large sums in raising piers both on the north and south side of the Avoca River, I fear the work has not proved of advantage to the fishermen—since, when obliged through stress of weather to run from their fishing ground for shelter, they find the entrance to the river a source of doubtful advantage; many boats sustaining much damage, and some being even wrecked in attempting to get over the bar. Mr. Andrews drew attention to an Act authorizing an annual grant for fishery purposes, and remarked that, though this Act is still in existence, the grant has not been paid for years; this, if devoted to its legitimate purposes, would enable great benefits to be conferred on the fishermen, and do away with or mitigate many of the drawbacks and disadvantages under which they at present labour.

Mr. Hoare referred at considerable length to statistics on the subject.

Professor Shaw referred to the state of the fisheries of the Isle of Man, and the thriving state in which they were in consequence of their harbour being well looked after by the Government. The filling up of our harbours was the only reason he could see amongst those advanced for the backward state of the fishery trade, and he thought a pressure should be put on the Government to improve and build Irish harbours and fishing piers.

Mr. Matthew M'Gowan, of Skerries (Master Mariner), said that he thoroughly agreed with Mr. Andrews in all his views and remarks on the fisheries around the coast of Ireland. He spoke from an experience of seventeen years, having fished off all the principal grounds of the north-west and west coasts, especially off Innisboffin; also off the south coast, and along the entire east coast; he had likewise been with his vessel to Iceland. He fully agreed with Mr. Andrews in the remarks he has made with regard to our harbours and their present state. A proper investigation of their present condition, and of their insecurity and unsuitability to large class fishing boats, is absolutely essential to a proper promotion of the fisheries. Skerries, in particular, is almost useless, from the shoaling of the best parts of the harbour, from the large quantities of ballast that have for years past been discharged there, not unfrequently, as Mr. Andrews has observed, 150 tons in the week. The large assemblage of English, Scotch, and Manx fishing boats that annually frequent Skerries would be greatly benefited by an extension of the harbour, as proposed by Mr. Andrews, not to speak of the large and increasing numbers of Irish boats that are throughout the year there. Besides, the localities of the fishing grounds are such, that great loss of time occurs in working to and from Howth with contrary winds. The improvement to Skerries, suggested by Mr. Andrews, would with strong easterly gales afford great shelter to all classes of vessels, as much damage in such weather too frequently happens along the east coast. At the Isle of Man, at St. Ives, at Wick, and at other fishing stations on the British coasts, good safety harbours have been formed; and, although petitions have been signed in favour of Skerries by English and Scotch fishermen, by those from Cumberland, Whitehaven, and Maryport, and also by the Drogheda Commissioners, there is no Member of Parliament to advocate our cause, nor Fishery Commissioners to report to Government in our behalf as in Scotland, when we have had 500 sail in our road in the fishing season. Much more could be represented, but Mr. Andrews has fully advanced all that could be said on the subject.

The Chairman (Sir E. Grogan, Bart.) thought that this evening's meeting would be productive of good results. During the last two years—the last session and session before—there had been a very important committee appointed to consider the taxation of Ireland, and that committee dwelt very largely on the point that Ireland had a right to some share in the national expenditure. The result was some expenditure towards the establishment of a dockyard in the Cove of Cork. There were five dockyards in England, and it is needless to dwell upon the advantages in the way of employment, and in the training of mechanics and skilled labourers, resulting from these establishments; and he did not see why, if they contributed a full share to the national exchequer, they should not have a proportionate share of expenditure in return. The subject of Mr. Andrews' paper was of the utmost importance to Ireland. Around our coasts there was an abundance of all kinds of fish, and plenty of willing hands to catch them; but some assistance on the part of the Government was necessary, to enable our people to take advantage of the almost inexhaustible supplies of good and wholesome food placed, as I may say, by Providence at our very doors. What we wanted were suitable fishery harbours for the shelter and protection of the fishermen and their boats; without such harbours they could not have boats, and without boats no fish could be captured. The first and most important point, therefore, was the erection of fishery harbours in suitable localities around our coasts, and the improvement of such as may have been heretofore erected;

and he did not see any more advantageous manner in which public money could be expended in Ireland than in the erection and improvement of such harbours, whereby immediate and remunerative employment would be provided for a large and deserving class of our population, and an abundant supply of food obtained for all classes—a consideration of no small importance at this moment. In asking for this assistance from the Government, they did not come forward as simple beggars to make an "ad misericordiam" appeal to the Parliament and Government of the United Kingdom, but they came forward to ask as *of right* that the same advantages, the same encouragement, which had been for so many years extended to Scotland in the developement and improvement of her fisheries, should be given to us; especially as the right of both countries to grants for fishery piers, and the encouragement of the fisheries, was specially reserved and continued to each of them by the Act of 1842. He (the Chairman) had had several interviews with Mr. Andrews on this subject; and Mr. Andrews had convinced him that Ireland was still fully entitled to the grant of £5000 a year for the erection of fishery piers and the encouragement of her fisheries, originally provided under the Act of 1819, but which of late years had been allowed to fall into abeyance. The right of Ireland to this grant was clearly reserved and continued by the Act of 1842. Previously to this Act, there had been various Acts passed at different times, regulating and varying the bounties to be given for the encouragement of our fisheries; these Acts expired in 1830, and by an order of the Government of that day all the accounts connected with them (and they were both intricate and complicated) were to be closed, and all further payments under them discontinued. This order only applied, and could only apply, to the bounties I have alluded to; for, however high an opinion we may be disposed to entertain of the prerogatives of the Crown, no order of the Crown, or of the Lord Lieutenant, can in these kingdoms repeal an Act of Parliament; the grant of £5000 a year under the Act of 1819 is therefore, in my opinion, still available for the purposes for which it was originally intended; and this opinion is, as I am informed, shared by gentlemen of high legal standing in this country. However, the authorities of the day, who were intrusted with the management of our fisheries, took a different view; the grant was allowed to fall into abeyance; and an arrear, amounting to upwards of £144,000, is now due to Ireland on account of this grant. If any confirmation of the correctness of the opinion I have ventured to express on this subject were required, it will be found in the Act of 1842, whereby all the Acts relating to our fisheries were by name (including that of 1819) repealed—an enactment which would have been useless and unmeaning, if the interpretation put upon these Acts by the Fishery Commissioners in 1830 had been valid and conclusive. We have a right, therefore, in my opinion, to have this arrear applied to the erection and improvement of fishery piers around our coasts; and it is needless to point out the great benefits which the expenditure of this sum for these purposes is calculated to confer upon our maritime population. A considerable expenditure for these purposes is required, and is absolutely necessary; this arrear would go a long way; and any additional sum which may be wanted would be amply repaid in the developement of the almost untouched mines of wealth surrounding our coasts, and in the peace and prosperity of our fishery population, for whose benefit so little has of late years been done. We have a market in Liverpool, and the other centres of population in England, for any amount of fish our people may take. The expenditure of the money to which I have alluded is sure, therefore, to be remunerative, while the greatest benefits to both countries will also flow from it. One of the recommendations of the Parliamentary Committee of last year was, that the opinion of the law officers of the Crown as to the repeal of this grant of £5000 a year under the Act of 1819 to Ireland should be taken; and I can have no doubt that General Dunne—whose zeal and determination in pressing the interests of his country are well known, and to whom we are indebted for the appointment of the Committee—will not lose sight of this point, but will crown his labours by urging the Treasury to consult the Attorney and Solicitor-General as to Ireland's continuing right to this grant, whereby such incalculable benefits would be conferred upon a large class of our population. The right of the people of Scotland to the grant of £3000 a year for the encouragement of their fisheries is preserved and continued to them under the Act of 1842, and this grant they enjoy up to the present time; it has, however, been largely increased, and the sums paid by the Treasury in aid of the fisheries of Scotland amount to £14,000 or £15,000 a year; while the £5000 a year continued to us by the same Act has, as I have already stated, been allowed to fall into abeyance; and nothing, or comparatively nothing, is paid towards the encouragement of our fisheries. Mr. Andrews has pointed out the extraordinary increase and developement of our fisheries under the system of bounties which formerly existed, and the great collapse which ensued when the bounties were withdrawn. But, while we cannot look to any renewal of that system, it is highly satisfactory to know that our fisheries are again progressing; and with the assistance (small in itself as it may appear) which the Trustees for bettering the condition of the people of Ireland are enabled to give, are again rapidly improving, and this without any loss to the Trustees. He has informed us that the loans made by the Trustees to the fishermen to enable them to obtain better boats and fishing gear have been thankfully and faithfully repaid; that an improvement in the number and size of the boats, and of the necessary nets, &c., for prosecuting the fisheries, more than commensurate with the extent of the loans, is observable; while the improvement in the condition and habits of many of the people engaged in the fisheries is also observable, and every well-wisher of Ireland must hope it will be permanent; but, to insure the permanence of that improvement, something should be done immediately by Government for the protection of the lives and properties of our fishing population, by the erection and improvement of fishery piers and harbours in suitable localities around our coasts. He concluded by thanking Mr. Andrews for having brought this very important subject so ably and so clearly before the meeting.

XXXV.—NOTES ON SOME OF THE DRIFT IN IRELAND. By G. HENRY KINAHAN, F. R. G. S. I., Senior Geologist of the Geological Survey of Ireland.

[Read before the Royal Geological Society of Ireland, March 14, 1866.]

CONNECTED with the drift in Ireland, I have observed various phenomena, to which I intend in the first place to call the attention of the Society, and afterwards to offer some suggestions as to the agencies by which they may have been produced.

First. The principal features of the hills and mountains would seem to have been formed in a great measure previous to the drift period; as in most of the valleys more or less boulder drift occurs, which usually rests upon "ice-dressed" rocks.

These præ-drift-formed features can be well observed in the mountains about Lough Mask, counties of Mayo and Galway. On looking at these eminences from some distance on the south, it will be seen that those on the north of the lake slope gradually down to the plain on the east; and that on the south of the lake, if a line be stretched from the mountains west of Toormakeedy (Slieve Partry) to the country east of Cong, this line would rest on the slightly-sloping table top of Benlevy,* the isolated mountain between Loughs Mask and Cong; and also that it would coincide with the previously mentioned slope on the north of Lough Mask.†

On an inspection of these hills, it will be found that the floors of the valleys are "ice-dressed," and that many of the valleys contain boulder drift. From this it may be inferred that at one time these mountains stretched in a gradual slope from Slieve Partry to Partry on the N. E., and to beyond Cong on the S. W.; that, after this, the area now occupied by Lough Mask and its tributary valleys, also the valleys between Slieve Partry and Benlevy, and the undulating ground between Benlevy and Cong, were denuded away, and that subsequently the rocks were "ice-dressed," and the boulder drift deposited in the valleys.

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* *Gable Hill;* so called from its likeness to the gable of a house.

† From Derradda, the hill S. W. of Oughterard, county of Galway, there is a good panoramic view of all the Yar-Connaught and Connemara hills, from which it would appear that they once formed one great slightly undulating table land.

Very similar results can be observed in respect to the hills in Slieve Aughta, the mountain group lying at the junction of the counties of Galway and Clare. Looking at them also from the south, it will be observed that the flats on the table-topped hills, east and west of Lough Graney, if connected, would form a continuous upland; and, moreover, they are capped with nearly horizontal basal beds of the Old Red Sandstone group. Now, these hills are separated by valleys in which boulder drift occurs, lying on the "ice-dressed" rocks.[*]

Second. Præglacial drift. Seemingly before the boulder drift period there was a drift that in places contains the remains of trees and plants. This drift has been found in the Bolleyneendorrish River valley, which lies eastward of Gort, county of Galway,[*] and on the Castlecomer table land, the mountainous district that lies at the junction of the Queen's County, Kilkenny, and Carlow.[†] Mr. Wilkinson also seems to have recorded præglacial drift at Nenagh, county of Tipperary, as there a black peaty bed was found, under "forty-three feet of hard calcareous clay, with numerous lumps of limestone intermixed, but unstratified." [‡]

Third. Ice-dressed Rocks. With reference to the class of phenomena now entered on, I have observed that there are two distinct sets of striæ, or scratches. The oldest one, which for convenience sake in these notes will be called the *Primary*, as its striæ correspond with the long axis of the "crag and tail," and of the principal "Tors,"[§] or ice-dressed hummocks of rock, has a general bearing of about N. N. E. or N. E., to the S. S. W. or S. W.; and the "crags and "tail" and "Tors" are precipitous, or *crag* towards the southward, and slope or *tail* towards the northward. The general bearing of the "crag and tail," the *Primary* "Tors," and the *Primary* striæ is slightly modified while crossing mountains and high ground, having westings or eastings respectively when the slope of the mountain or high ground is eastward or westward.

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[*] See "Mems. Geological Survey, Ireland," Ex. Sheets 115 and 116, p. 28.

[†] See "Mems. Geol. Survey, Ireland," Ex. Sheet 137; and paper by Author, "Geological Magazine," Oct., 1865.

In a Paper read before the Society, May 13th, 1846, "Note on the Tertiary Deposits of the County of Wexford," the author, Captain James, R. E. (now Sir H. James), mentions seventy-four species of fossil shells, some of which are Arctic that were found in what he seems to consider præglacial drift. (See "Journal of the Geological Society, Dublin," vol. iii., p. 195.)

[‡] See paper by T. Oldham, M. R. I. A., "Journal of the Geological Society of Dublin," vol. iii., p. 64.

[§] This English name for the dressed hummocks of rocks has been copied from "Frost and Fire," by J. W. Campbell, as it is more concise than the Continental term, *Roches Moutonnees.*

The Primary set of striæ is crossed at various angles by another set, which may be called *Secondary*, that always coincides with the direction or general fall of the valleys in which it occurs. The *Primary* striæ are very often quite obliterated by those belonging to the *Secondary* set; and often the *Primary* "Tors" are modified by the *Secondary* ice. One side of the "Tors" may have been planed away by the latter, or one corner of the original crag of the "Tors" cut off, giving them a one-sided appearance. The *Secondary* set may run in any direction across the *Primary* "Tors," but it rarely coincides with their axis, except where such axis agrees with the direction or general fall of the valley.

As every valley has striæ belonging to the *Secondary* set, and as most valleys have smaller ones opening into them, it follows, that at the junction of a main valley with its tributary there may be two sets, viz., the striæ of the main valley and the striæ of the tributary; or there may even be three, as the *Primary* set in this place may not be completely obliterated; and then in this case, besides the Secondary striæ just mentioned, the Primary striæ would also occur.

Fourth. Boulder drift.—This deposit is principally made up of fragments and boulders of the subjacent rocks; but in many cases foreign erratics have also been detected, such as nearly always belong to rocks in the country lying north-eastward.* In some places, however, isolated patches of a foreign drift may be observed with scarcely a fragment of the subjacent rocks in it; but often in this case the foreign drift will be found to be overlaid by local boulder drift.

It has been observed that in many of the wide valleys, and on parts of the central plain of Ireland, much of the boulder drift occurs in *esker-like mounds*, which have a rude parallelism to one another, and that often associated with them are striæ that have a bearing similar to the parallelism of the mounds.

Fifth. Post-drift gravels, or esker-drift.—In places on the low country the boulder drift is washed into gravels and sands, which are sometimes spread over the ground, but are more often piled up in long ridges (*Eskers*), or continuous systems of mounds and duns.

These eskers, while crossing high ground, or ending on a mountain slope, break into gravel mounds and short ridges that run in various directions, and among them are small mounds of boulder an *rocky drift*,† against which the esker drift is often piled. For these parts of the esker drift, I have in a paper read some time since before the Society, suggested the name of *Shoal Esker.*[*]

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* In a few localities—as, for instance, the south part of the county of Mayo—the Boulder drift has evidently come from the southward. The explanation will be given hereafter.

† Rocky drift is a term used for a peculiar drift, which consists of large and small angular, subangular, and round blocks of rock, mixed with a little clay or gravelly clay; in some places it seems to be half-washed boulder drift, but when found at high levels in the hills it has the appearance of being the *debris* left after the melting of the glaciers.

Near the foot of some of the mountain slopes there are banks or shelves consisting of boulder drift, rocky drift, and gravels; and connected with these banks are occasionally to be seen irregular ridges, which run with the outlines of the hills, receding from them if the mountain slopes are gentle, and approaching quite close or disappearing altogether if the slopes are steep, or if cliffs are present.

Sixth. Erratic blocks.—Sometimes on the boulder drift, at other times on the esker drift, are found large and small erratic blocks which may be north, south, east, or west of their parent rocks.

Seventh. More recent deposits.—Overlying the boulder and esker drifts are deposits consisting of peat (*bogs*) alluvium (*corcases* and *callows*), shell marls, brick clays, sands, &c.; none of these will be again mentioned in these Notes.

The task now before me is to try to account for these different phenomena by natural causes. The first questions I propose to examine into are, whether the country was covered by a large ice field; or an arctic current with icebergs, flowed over it. As the former is the older theory, it shall be considered first.

Land Field Ice.—Previously to the boulder drift period, as the land was gradually rising, the outlines of the present features of the country were carved out by marine denudation; and, when the land had risen high enough, the climate must have been somewhat similar to what we now have in Ireland, would seem to be proved by the vegetable remains which have been found in the præglacial drift. As the land rose, the climate gradually became colder, glaciers began to form, and the ice finished the work that the denuding power of water had begun. This latter would seem evident, as in the valleys and *Cooms*[†] is found boulder drift reposing on "dressed" and striated rocks. The ice should increase more and more as the climate became colder, until eventually the country was covered with a field of ice, which was at least 2200 feet thick.[‡]

The field of ice would seem to have had a general movement from N.N.E. or N.E. to the S.S.W. or S.W. by which the "Crag and Tail," the primary "Tors" and the primary striæ were formed. This ice sheet would in time sweep off all the vegetable soil, &c., that had previously covered the country, except such portions as were protected by favourable circumstances.

The latter would have been the case in the localities before mentioned, as on the Castlecomer table land, where the præglacial drift was sheltered by the numerous small hills that occur there, and in the Bolleyneendorrish River valley, where it seems to have been preserved by the bars of rock that cross the valley.

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[*] See "Dublin Quarterly Journal of Science," vol. iv., p. 109.

[†] Local name for a valley that runs into a mountain or hill, and is bounded on three sides by precipitous or nearly precipitous sides, answering to the French term *Cul-de-sac*, or the Scotch *Corrie.*

[‡] Bengower (2184 feet), about eight miles east of Clifden, Co. Galway, is polished and dressed to its summit, and Mr. Campbell has recorded on Shanaunnafeola, Co. Galway, horizontal grooves at 2000 feet (See "Frost and Fire," vol. ii., p. 165).

Again, that subsequently the country sank, and, as the climate became warmer, the field of ice gradually broke up into local systems of glaciers which flowed down the different valleys. During this process the Secondary striæ would be produced, and the form of the Primary Tors modified.

One of the best places with which I am acquainted for exemplifying the different actions of the "field ice" and of the local glacier is Slieve Bawn, Co. Roscommon. This mountain rises from the central plain of Ireland, as a large "crag and tail," that *tails* towards the N. N. E. (N. 20° E.), and *crags* towards the S. S. W. On the east slope, the primary and secondary striæ are well marked. The primary striæ have a westing as the ground slopes to the eastward; near the foot of the hill where the slope is gradual, being N. 22° W.; and higher up, where it is steep, being N. 32° W. The top of the hill is principally covered with heather and bog, and I observed no striæ. The west slope is banked with drift, but at the base the primary striæ run N. 13° E. On the western slopes no secondary striæ were observed but those on the eastern slopes run with the fall of the ground (about N. 83° E.).

The ice of the ice field on the low country would first be affected by the change in the climate, and gradually slide off into the area now covered by the sea, leaving our present low country to be occupied by the ice supplied from the higher elevations. Part of the latter in its downward passage was caught in the valleys, and on the hill sides, and remained there until it melted, and left its *debris*, which now form the isolated patches of foreign boulder drift. If while these remained in some of the valleys, and in patches on the hill sides, a glacier flowed over, and melted on them, when the ice finally disappeared from the country, it would leave local boulder drift covering foreign. To the northward of large mountain groups, the Boulder drift is sometimes composed of fragments of the rocks from those mountains. In these cases the Boulder drift is the residue of a large glacier that flowed northward from those mountains; an example of this is the Boulder clay of the south part of the county of Mayo, that in a great part consists of fragments of the rocks which compose the Partry mountains.

Good examples of the isolated patches of foreign boulder drift were observed on the mountain group called Slieve Aughta. The rocks composing these mountains are of the Silurian and Old Red Sandstone ages, while the country for miles on the north and north-east is Carboniferous Limestone. In the valleys on the north there are various patches of limestone boulder drift on Silurian and Old Red Sandstone ground.*

If the movement of the ice field was from the N. N. E., it would have carried with it the *debris* of the limestone country on the N. N. E.; and when the climate became warmer, and after this movement ceased, this ice charged with limestone *debris* was on the hills. This mass of ice, going up the hills from the N. N. E. and down the hills towards the S.S. W., had planed all the rocks, leaving a tail towards the N. N. E., and a foil or low cliff towards the S. S. W. (see Fig. 1). But when the field of ice broke up and the ice began to slide down the different slopes, part of it would go with the arrow at (*a*), and, having no impediment, it continued its course down the hill; but some of it went with the arrow at (*b*), part of which was caught behind the *foils* (*c* and *c*), and kept there until it melted, and its *debris* formed the before mentioned patches of limestone boulder drift.*

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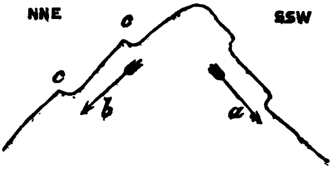
* See "Mems. Geological Survey, Ireland," Ex. Sheets 115, 116.

Fig. 1.



Similar results were remarked on the Arra and Keeper Mountains, county of Tipperary which respectively lie N. E. and S. E. of Killaloe.† On the Castlecomer table land, where we have coal-measures with a limestone country on the N. and N. E., the hills forming its margin, and some of those in the interior, are free from limestone boulder drift; while other hills in the interior, when there is no fall from them, are covered with it.‡

Part of the central plain of Ireland may have been so flat, that, when the movement of the ice field ceased, the ice then on it could not slide away; it would therefore melt where it was, and deposit its *debris*. If this occurred at the base of a mountain group, it would necessarily bank up the ice on the mountain slope, and prevent the greater part of it from sliding down, and therefore the latter would have to melt and deposit its *debris* on the slope of the hills. In this way the continuous sheet of foreign drift up the sides of some hills might be accounted for.

All this time the land is supposed to be sinking; and if we next suppose it to be about 300 or 400 feet lower than its present level, and the climatal conditions of the country to be similar to those of Baffin's Bay and thereabouts at the present day, there would be an open sea in the centre of what is now Ireland, bounded on the north-west and south by numerous ice-clad islands, the depressions between many of which would be occupied by large glaciers; round the land there would be an

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* The author of "Through Norway with a Knapsack" directs attention to the boulder drift under the glaciers in that country.

† "See Mems. Geological Survey, Ireland," Ex. Sheet 134.

‡ See "Mems. Geological Survey, Ireland," Ex. Sheet 137, p. 50.

I should mention that all round the Castlecomer table land there is a Carboniferous Limestone country, and as patches of limestone boulder drift are found all down the valley of the River Dinin which leaves it on the south, this case does not prove the drift to have come from the north-east, which would have been proved had granite fragments from the country about Ballintore been found. On looking at my notes I do not find any recorded, but I never carefully looked for them, because while examining that district my attention was principally directed to the coals.

"Eisfod," or "Icefoot," and numerous icebergs would be floating about in the adjacent waters. But, before we proceed farther, let us consider what would have been the effects of "the Baltic current,"* instead of a large ice field.

Mr. Campbell, in "Frost and Fire," seems to consider that at the beginning of the glacial period the land was sinking, instead of rising; and that as it sank, and the current from the North Pole, *vid* the Baltic, became deeper, the climate gradually became colder; that the land afterwards rose, while the climate gradually became warmer, as the Baltic current became shallow.

Before the country sank, it must have been as high as it is now, or its climatal condition must have been very similar, as the vegetable remains found in the præglacial drift of Ireland and England are like what grow at the present day.† During the depression and uplifting of the country, marine action would cut out the principal features; and when it rose high enough for land ice to form, a new denuding force would have been at work to finish the excavation of the valleys and cooms, and leave them nearly as we now find them.‡

The results from "the Baltic current" would have been very similar to those from "a field of land ice." Most of the præglacial drift would have been swept away, with the exception of a few small patches which were favourably situated; the floating icebergs would "dress" the rocks, and produce the Primary striæ; the latter would run in their regular course (about N. 30° E.) when the icebergs crossed the open sea, or the tops of the submerged hills; but where an iceberg was too large to float over one of the latter, it would have to coast round it, during which process the primary striæ on the hill's sides would be produced, having a westing if they had to go round the east side of a hill, and an easting if they went round the west side. Afterwards, as the land rose, and the hills became awash, icebergs would strand on them, melt and deposit the boulder drift. This boulder drift would rise with the land, but afterwards the most part of it would be carried off by the glaciers, isolated patches only remaining, that were protected in valleys, or behind *foils*; and if a glacier flowed over one of those isolated patches, when the ice finally melted, it would leave local boulder drift on foreign. The banks of foreign drift up the slopes of the hills would be formed by a large iceberg grounding and melting at their base, and thereby preventing any boulder drift above from being carried down.

The land during all this time was gradually rising; and when Ireland was about 300 feet or 400 feet lower than at present, we may suppose, as previously suggested, that its climatal conditions were similar to those of Baffin's Bay at the present day. I have now brought the two theories to the one point, and before we go farther let us review them.

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* See "Frost and Fire."

† See "Mems. Geological Survey, Ireland," Ex. Sheets 115 and 116, p. 28; also Lyell's "Antiquity of Man," 2nd Ed., p. 215.

‡ Atmospheric agencies could have done very little work in carving out the features of Ireland *since* the glacial period, as the rocks forming the bottom of all the large valleys and cooms are polished and grooved by ice action. A few of the small valleys and *ailles*, or ravines, especially if the subjacent rock is of a soft nature, may have been cut by atmospheric agencies, but in many of them ice action is visible.

According to the "Land Ice theory," if the features of the country had not previously been sculptured by marine denudation, the land must first have risen about 10,000 feet higher than at present to allow them to have been formed by atmospheric agencies and ice action.*

During the latter part of the glacial period the land must have sunk to at least 300 or 400 feet below its present level;† and subsequently it must have risen again till it attained its present altitude.

According to the "Baltic Current" theory the land must first have been at about or a little higher than its present altitude;‡ it then gradually sank until all or nearly all was covered with water, and afterwards it gradually rose until it reached its present level. In favour of this theory we find marked terraces, which appear to be ancient sea margins, at various levels, which ought not to exist if the country had been covered by a field of ice. These on Slieve Aughta are well developed in the neighbourhood of Lough Graney; the highest being at about 1200 feet, and the lowest a little above 300. In the Burren mountains, county of Clare, there are also well-marked terraces; and in the hills of Yar-Connaught, N. W. of Galway town, lines of cliffs were remarked at heights varying from 300 to 1000 feet. Against this view is the following:—If the boulder drift is the *debris* left by ice carried from the N. E. by a great current, it ought to be composed of fragments of rocks that formed hills far away to the N. E.; but all the fragments in the previously mentioned isolated patches of foreign boulder drift seem to be of rocks that are found in the country *immediately* to the N. E., as pointed out when describing the isolated boulder drift patches on Slieve Aughta, &c.

The stumbling-blocks in the way of the ice-field theory are, that incalculable ages of time must have lapsed since the setting-in of the glacial period; and if all these phenomena were caused by land ice, this monstrous glacier must have been at least 2200 feet thick when passing over Ireland, and it must have started near the North Pole, and flowed south-westward far beyond this country; there is no existing glacier at all to be compared to what it must have been.

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* The reason I mention this particular height is, that "it has been shown by the soundings of Vidal and Hoskyns that on the west of Ireland the sea bed is in the form of a submarine plateau, extending from 50 to nearly 200 miles into the Atlantic, with a depth rarely exceeding 200 fathoms. Beyond the line circumscribed by this depth the plateau suddenly ceases; its edge merges into a slope, which descends at a considerable angle, never stopping until the bottom of the great abyss of the Atlantic is reached at a depth of from 1700 to 2000 fathoms." This slope may have been the margin of the land during the Glacial Period as previously suggested by Professor W. King, of Galway. See "Frazer's Magazine," October, 1863.

† I do not mean to say "that the land did not sink lower than 300 or 400 feet;" but what I want to express is, that "a short time previous to the close of the glacial period the land was at about that level." If the country sank lower than this, it would quite change its conditions, as nearly all the land ice would disappear, and as the land again rose a new system of glacier would have to form; in fact, it would bring the country to similar conditions to those Mr. Campbell suggests.

‡ It might have been 1200 feet higher than at present, and have included the whole of the 200-fathom plateau.

Let us now return to the "Eisfod," or "Icefoot." Doctor Kane, in the "Arctic Exploration," vol. i., pp. 175, *et sqq.*, says of it:—"In this our high northern harbour, an Icefoot is a perennial growth, clinging to the bold faces of the cliffs, following the sweeps of the bays and the indentation of rivers. This broad platform, although changing with the seasons, never disappears." Afterwards he mentions that "It grows wide where the land is low, and narrow where it is high." Doctor Kane also mentions the quantity of the *debris* of the rocks, &c., which it supports. Let us now suppose that a similar "Icefoot" existed in the country which now is Ireland when it was 300 or 400 feet lower than at present. This "Icefoot" should be charged with *debris* of various kinds, that would be dropped when the ice melted, and would form the banks and shelves which exist near the base of some of the mountains. In favour of this idea we find that these banks agree with Doctor Kane's description of the "Icefoot," as they spread out from the hills where they are sloping, and get narrow where they are precipitous. If these shelves are formed by the *debris* from the melting of the "Icefoot," the irregular ridges of rocky and gravelly drift which are associated with them ought to mark the severity of the different winters; for Doctor Kane remarks, "that in a severe season the Icefoot extends much farther out from the land than during a mild one;" therefore, during the thaw after a severe winter, the *debris* carried by the "Icefoot" would be dropped far out, and form one of the outer ridges; while after a mild winter it would be dropped much nearer in, and form one of the inner ridges. All the different modifications we find in these banks and shelves of drift could be accounted for by circumstances going on at the present day; for where there is gravel and sand, it shows that there was a strong current which washed and sorted the *debris* as it fell from the "Icefoot;" and the rounded bluff hills of drift on the mountain slopes show that a "slide," or a stream, during the thaw had emptied itself over the "Icefoot."*

Looking at the contour map of Ireland, it will be seen that there is a low tract extending south from Killala Bay by Castlebar, Galway, and Ennis, to the Shannon; this tract seems to be nearly free from esker and boulder drift, and from this and other reasons mentioned in the paper of mine previously referred to,† I suggested that a continuous current flowed here from north to south. If this current existed, we would have the area now occupied by Ireland under the following conditions:—The central plain of Ireland would be a sea that had an open space on the east, and was bounded on the north and south by islands, between which the tide could ebb and flow, while on the west there should also be islands, but between them and this sea there would be a continuous current, that should prevent the tide having ingress or egress through them; these circumstances ought to make the tidal conditions somewhat similar to those of the present day. If the tidal map of the Irish Sea in Johnson's Physical Atlas be examined, the north and south tidal waves will be seen to meet between Dundalk and the Isle of Man; moreover, if the eskers on the published Sheets of the Geological Map of Ireland be looked at, it will be found that they form a compound bar, occupying a strip of country which stretches nearly east and west from Dublin to Galway; this compound bar consists in parts of well-defined ridges or *bar eskers*, and in other places of *shoal eskers;* the bar eskers from Galway to Tullamore, or thereabouts, are usually on ground under the 250 feet contour line; and from Tullamore to Dublin on ground under the 300 feet contour line, while the shoal eskers towards the west are on ground between the 250 feet and the 300 feet contour line; and towards the east, between the 300 feet and 400 feet contour line. From these facts I would suggest that the land was then between 300 and 400 feet lower than at present, having since risen more toward the east than it did at the west; that the climate was somewhat like that of the region of Baffin's Bay and thereabouts at the present day; that this compound bar of eskers was formed by the meeting of the northern and southern tidal waves, which washed and sorted the boulder drift; and that the complicated structure of this bar is due to the nature of the ground, having to fringe round some islands and submerged hills, to form bars between others, and shoals in the shoal water.*

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* (See "Arctic Explorations," vol. ii., p. 226.) Since the above was written, I find, Mr. Campbell, in "Frost and Fire," has anticipated me in considering that these shelves of drift on the mountain sides were formed by an "Icefoot." It is very satisfactory to me to find that a man who has watched the "ice engine at work" had come to the same conclusion as one who only had seen "the work done."

† (See "Dublin Quarterly Journal of Science," vol. iv., p. 109.) In that paper, besides the current just mentioned, I suggested that there was also another current that entered toward the N. E., "on the north of Lough Neagh, and from thence flowed by that lough, Cavan, Loughs Ree and Derg, to the mouth of the Shannon." This current could not have been a *continuous* current; for if it were, the various bar eskers which cross that valley would have been swept away; but that some current besides the tidal current existed hereabouts, would seem to be suggested by the

If this compound bar was formed by the meeting of the northern and southern tidal waves, there ought to be bar eskers in some at least of the straits between the islands which bounded the Esker Sea on the north and south; as in these narrows, the tide could not come in or go out as fast as in the open space on the east; about the northern straits

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breaks in the bar eskers to the north-east of Portumna, and also by the shoal eskers on low ground that exist north from Portumna to Kiltormer. These latter would have been formed by the meeting of this current and the south tidal wave, hereafter to be mentioned.

If Mr. Campbell's Baltic current once existed, the north and south current from Killala to the mouth of the Shannon would be the last trace of the once great current that flowed over this island from the North Pole.

* While examining the gravels in the eskers, I have never found striated or polished blocks high up in them: near the base I remarked a few; but these latter never had the fresh look of those that are newly extracted from the boulder drift, but rather the appearance of the polished blocks that are found in the bed of a stream after a large flood. Many geologists class the *esker-like* ridges of boulder drift with the true eskers or kaims. This appears to me not to be correct, as in many places the esker gravel is banked against these ridges; and if a section across them is exposed, a well-marked boundary will be found between these two kinds of drift.

I can give no information, but in all the southern straits with which I am acquainted there are bars. In the valley of the Barrow there is a bar near Bagnalstown; in the Maryborough valley, at that town; in the Shannon valley, south of O'Brien's Bridge; in the Nenagh valley, at Kilmastulla; and in the valley of the Suir, at Tipperary.*

It will naturally be asked if the eskers were formed by marine currents, why do they not contain fossil shells? The condition of the eskers is against fossil shells now being found in them, as it is of such a porous nature, that they would have decayed away years ago. I remember about fifteen years ago, at a place called the Breaches, seeing a river cut made through the bank of gravel that forms the sea margin between Bray Head and Wicklow. This is quite a recent formation compared with the esker gravel, and yet in it all the shells that were found were so rotten, that they crumbled in pieces on being handled. Furthermore, I believe that the places where shells once were can be observed in the eskers, as in most sections that I have examined, little pockets of "Earth foam" were remarked, which may be the calcareous residue of the shells. In the sandpits N. E. of Carrigogunnel, county of Limerick, there are a great number of them, and in some I even imagined that I could recognise shell forms.†

Furthermore, in favour of the marine origin of the eskers, are the erratic blocks perched on them. These latter will again be mentioned farther on in these Notes.‡

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* Doctor Kane, in "Arctic Exploration," mentions glaciers that fill up straits between some of the Arctic islands. If a similar phenomenon occurred in one or more of the straits out of the Esker Sea, these strait glaciers, if I may so call them, should be more likely to occur among the northern islands than the southern. Of course, if a glacier had filled up a strait, no *bar esker* could now be found in it.

† Mr. Oldham seems to have found fragments of shells in the esker close to the town of Roscrea, county of Tipperary. (See his paper, "Journ. Geol. Soc. Dublin," vol. iii., p. 66.)

‡ If the eskers in Ireland were formed by the meeting of the tidal waves, the *kaims* in Scotland ought also to have a similar origin. This appears not to be unlikely; for Mr. Stevenson, of Dunse, was kind enough to mark for me, on a map of Scotland, most of the principal kaims, the mass of which occupied a tract of country between the Frith of Clyde and Berwick-on-Tweed. On looking at the tidal map, it will be seen that a faint south tidal wave extends as far north as Berwick. This wave could not have formed the kaims; but, if England and Scotland were lowered from 600 to 800 feet, the tidal conditions would be quite altered; and, in place of a faint wave, the full force of the south tidal wave would sweep up at least as far north as this place.

If the eskers were formed by the meeting of the north and south tidal waves, and if there was during the esker period a continuous current flowing from Killala to the mouth of the Shannon, esker drift ought to have been deposited at the meeting of the tidal waves and that current. High ground (Slieve Aughta and Slieve Bernagh) occurs where the south tidal wave and this current ought to join; but there is low ground to the north, where it and the north tidal wave should meet. The maps of the last-mentioned place have not yet been published by the Geological Survey of Ireland; but Mr. Birmingham, in his papers read before the Society (see its "Journal," vol. viii., pp. 28 and 111), mentions the eskers which occur in that country. These, if formed as I suggest, ought to have a general north and south bearing, unless when going over or round high ground, when, of course, the general bearing would be more or less deflected.

The next question to be considered is: Has the east portion of Ireland, since the glacial period, risen more than the west? If my suggestions are correct, the eskers were formed near the close of the glacial period; and the *shoal eskers* are those parts of the eskers which were awash, or had not more than fifty or sixty feet of water on them, while the *bar eskers* were formed in deeper water. Near Galway, the eskers shoal below the 250 feet contour line; in the neighbourhood of Athenry, they shoal above the 250 feet contour line, and are barrier eskers up to about that level. This is well shown about four miles north of Loughrea, where an esker ridge runs S. W. from Ballafa Bridge towards Raford, the highest point in which is 232 feet; a little S. E. of this, about Benmore, the country is over 250 feet, and we find it covered with irregular hills; and if we trace the esker ridge towards the N. E., east of Woodlawn demesne, we find it breaking into a large shoal esker on the high ground there situated; while farther east, between Kilconnell and Ballinasloe, where the ground is not so high, it again becomes a bar esker.

The farther we go east, the higher does the level for the shoal eskers become: east of Tullamore the bar eskers are found above the 250 contour line; and at the Green Hills, county of Dublin, the 200 feet contour line runs close to the base of the eskers, while there is a rather distinct mound forming part of the esker, the summit of which is 254 feet above the sea, but what seems to be the highest part of the esker is 290 feet. Moreover, if crossing into Scotland, we shall find in the neighbourhood of Greenlaw that the Ben Shiel eskers are 700 feet above the sea level.* Besides, if the theory that the eskers were formed by tidal currents before the end of the glacial period is correct, there is evidence in the county of Cork that the ground north of Bantry Bay has not risen more than 140 feet since the ice disappeared from the country. This can be proved in one of the valleys immediately east of Hungry Hill, the valley of the north branch of the Reen River, where striæ may be found winding down an *aille*, and ending at a well-marked terminal moraine, on ground only 140 feet above the present level of the sea. This moraine could never have been under water, or it would have been washed out of shape.†

These facts would give the following levels:—

Maximum height of the sea at Bantry Bay, . .	140 feet.
Top of shoal eskers near Galway, ...	about 240
Top of shoal eskers east of Athenry (Clooncar), .	269
Top of bar eskers S. S. W. of Woodlawn (S. W. Ballafa Bridge), ...	232
Top of bar esker east of Tullamore, . . .	about 270
Top of bar esker, Co. Dublin, Green Hills, . . .	290

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* See paper by Mr. Stevenson, of Dunse, "Proceedings Berwickshire Nat. Club," vol. v., p. 124.

† As the highest ground in Ireland lies in the counties of Cork and Kerry, the glaciers may have existed thereabouts after they had disappeared from the rest of Ireland, and therefore after the age in which the eskers were formed. If that was the case, this terminal moraine may have been formed at a much later date than I have mentioned above.

Icebergs floating about in the Esker Sea, wafted hither and thither by the currents and the wind, would in their transit drop the erratic blocks that are found perched on the esker drift,* and also some of those which occur on the boulder drift, but seemingly not all, as many of the blocks on the boulder drift appear to be its residue, left after the associated clay, &c., were carried away. There are to be found on the crags in the county of Galway numerous large blocks, most of which are evidently the residue of the boulder drift, as under some of them are found patches of it; and if the residue of the boulder drift was left on the crags, why might not similar blocks be left on the boulder drift, if only part of the mass had been swept away? We also find in favour of this idea that some of the blocks which seem to be lying on the boulder drift are in reality half buried in it. That some of the blocks even on the bare crags were dropped from icebergs would appear evident, because in places they can be traced in lines from their parent rocks, and in others they occur in groups, small and large blocks being mixed together, evidently the freight of a stranded iceberg. If these icebergs and glaciers existed during the esker period, their existence would account for the erratics being found miles east, and even north, of the course they would have taken if carried either by the "field ice," or on icebergs in the "Baltic current."

A peculiar porphyritic granite, with large pink, or rather flesh-coloured crystals of felspar, is the rock in the hills N.W. and W. of Galway town. Large blocks of this granite are found north, east, and south-east of their present site. They are found north of it in the valley that extends west from Oughterard, a small town about fourteen miles N.W. of Galway town. In the neighbourhood of Headford, which lies east of Oughterard, they are rare; but opposite Galway Bay they become plentiful, and stretch for miles towards the east, occurring in great numbers between Woodlawn and Loughrea; and some I have remarked as far east as Ballinasloe, Eyrecourt, and Portumna; and Mr. O'Kelly has found them even farther east, on Slieve Bloom, the mountains that lie at the junction of the King's and Queen's Counties.†

On the west parts of Slieve Aughta, and on Slieve Bernagh (the mountain group north of Limerick), they occur; but I do not remember having remarked any of very large size. Opposite the mouth of the Shannon they are found a long way to the east, Professor Haughton and Mr. A. B. Wynne having noted large ones in the neighbourhood of the Silvermines, county of Tipperary: and I myself have remarked that drift in some of the valleys on the west of the Keeper Mountains is nearly entirely made up of granite fragments.

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* For some *locale* of remarkable erratics on eskers see "Mems. Geol. Survey of Ireland," Ex. Sheets 115 and 116, p. 34, and the forthcoming Mems. of Sheets 106 and 107. All these are granite erratics; but a large limestone erratic, about 8 ft. × 6 ft. × 3 ft. can be seen by any one who drives from Gort to Loughrea, perched on a sand dun, about 2·5 miles south-west of the latter place; and in the county of Limerick, south of Shanagolden, I observed another, about 9 ft. × 5 ft. × 3 ft., also perched on a sand dun. In both these places the duns have been opened to carry away the sand and gravel, so that a section of the materials that support the erratics can be observed.

† See "Mems. Geol. Survey, Ireland," Ex. Sheet 127.

I should offer the following suggestions to account for these blocks being more numerous in certain places than in others:—The Oughterard valley was filled with a glacier similar to one of the large glaciers mentioned by Dr. Kane, as occupying straits between islands in the Arctic Seas. This Oughterard glacier would have southern branches which started from the porphyritic granite hills; and on these branches porphyritic granite blocks should be carried to the main glacier, and by the latter to Oughterard, where they would be floated off on icebergs into the previously mentioned current that ran from Killala to the Shannon. The icebergs that were launched into this stream ought to have been carried south by its current, and undoubtedly many were; but if the west wind was as prevalent then as now, which is not unlikely, many of the icebergs would have been driven out of the stream. The icebergs floating down with this stream were sheltered from the west wind, except while crossing the openings at Galway Bay, the Ennistymon valley, and the mouth of the Shannon, therefore the icebergs that were launched at Oughterard ought to float to Galway Bay; but when there, some were driven east by the west wind, many of which were stranded on the high ground about Loughrea, Woodlawn, &c., while others of them were driven as far east as Slieve Bloom. Similarly the blocks in the neighbourhood of Silvermines could be accounted for; as the icebergs that carried them might have been driven eastward by either the wind that came through the Ennistymon valley, or up the mouth of the Shannon. In the former case they would have been floated through the Scariff valley, which lies between Slieve Aughta and Slieve Bernagh, in the latter case up the valley of the Shannon.

Some of the icebergs that were driven out of their course by the wind that blew up the valley of the Shannon would drop their freight in the country south of Limerick, and on the Galtee mountains, where they were found by Mr. Wynne;* and a few might even be carried south by the tide into the county of Cork, which would account for the granite boulders found by Mr. W. L. Willson and other observers.

Before leaving the erratic blocks, I should mention that S. W. of Woodlawn, a little S. W. of Ballafa Bridge, large blocks of the porphyritic granite are found perched on the eskers there situated; and that farther S. W., south of Raford, they were also observed on esker drift, and Mr. Foot has found them similarly circumstanced in the neighbourhood of Ballinasloe.

These facts about the erratic blocks would seem to me to be additional evidence in favour of a north and south current from Killala Bay to the Shannon. Moreover, there is the evidence that I put forward in the previously quoted paper of mine, that the drift on the hills bounding the Shannon on the south, from Foynes to Tarbert, is in a great measure made up of fragments of the rocks that form the hills in the west parts of Galway and Mayo, in some places being altogether composed of them. Besides, if this current existed, it would always be inclined to go west, and therefore it would hug the Yar-Connaught and west of Clare hills. At the mouth of most of the mountain valleys in Ireland there is an accumulation of drift, the *debris* brought down by the glaciers; as, for instance, opposite the valleys coming out of Slieve Aughta, Slieve Bernagh, &c.; but, comparatively speaking, there is none opposite the valleys that open towards the east out of the Yar-Connaught and west of Clare hills, it having been carried away by this current.

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* See "Mems. Geological Survey, Ireland," Ex. Sheet 165.

In conclusion, allow me to allude to the different cliffs, terraces, &c., which seem to be ancient sea margins. In a previous part of these Notes I have referred to those in Yar-Connaught, Slieve Aughta, and the Burren, and mentioned that they were at various heights between 300 and 1200 feet. If these were ancient sea margins, during the elevation of the land, each must mark a period of rest, one of which periods may have been during the formation of the eskers. That there was a period of rest while the eskers were being formed is likely, if the idea "that the west of Ireland was about 300 feet lower than at present" be correct; for, as before mentioned, there are terraces at that height in Yar-Connaught, Slieve Aughta, and the Burren hills. To the west of Ballingarry, county of Limerick, and about four miles south of Rathkeale, I traced a well-marked gravelly beach for miles. The Ordnance height on this beach, or a little above it, is 287 feet; and to the north of the Shannon, on the south slopes of the Cratloe hills, there is a bank of fine sand at about the same level: these would give the following height for the margin of the Esker Sea in the West of Ireland:*—

	Feet.
Limerick,	287
Clare, south of (north slopes of Cratloe hills), about	290
,, north of (Burren hills),	300
,, ,, (Slieve Aughta),	300
Galway, south of (Slieve Aughta),	300
,, west of (Yar-Connaught)	300

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* The heights of the margin of the supposed Esker Sea in the east of Ireland are not given, as I have not carefully examined that part of the country.

In the following papers reference is made to marine fossils found in gravelly drift, principally in the east part of Ireland:—

"Account of certain elevated Hills of Gravel containing Marine Shells which occur in the County of Dublin," by Dr. Scouler, &c., &c. ("Journal of the Geological Society of Dublin," vol. i., p. 266). The author mentioned having found these shells at Howth up to an elevation of about ninety feet, and on the south of Bray Head at about 150 feet. Of them he says, "All the shells whose species could be ascertained belong to races at present existing in the Bay of Dublin."

"On the more recent Geological Deposits in Ireland," by T. Oldham, M. R. I. A., &c. ("Journal of the Geological Society of Dublin," vol. iii., p. 61). In this Paper, Dr. Oldham, besides adding to Dr. Scouler's list, refers to Captain Portlock having found marine shells at 200 ft. above the sea in the county of Sligo, and in the county of Londonderry up to 300 feet; to Messrs. Bryce and Hyndman, at Belfast, up to 150 feet;

I have now laid before the Society suggestions to account for the different phenomena that I have remarked connected with the drift in Ireland; and I think it will be found in favour of these suggestions, that all the phenomena have been produced by *existing agencies, gradual in their process, and such as have been noted by different Arctic observers.* The north and south current, from Killala Bay to the Shannon, may be objected to, as it may be said, "If it prevented the tide from going east between Killala and the mouth of the Shannon, it would also prevent it farther north, and so altogether change the tidal system." But farther north, where the ocean was deep, might not the tide have flowed over this current, as it is supposed to flow over an Arctic current at the present day off the west of Ireland?

In these Notes no suggestions have been offered to account for "the rudely parallel esker-like ridges of boulder drift" that are found in wide valleys and on sloping ground. All I can say about them is, that they seem to be connected with the secondary striæ; for I have found them running in the same direction in the valley between Slieve

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to Mr. Smyth, at Portrush, at about ten feet; and to Mr. (now Sir R.) Griffith, at Tarmon Hill, county of Mayo, at 250 feet. He also mentions the following localities of his own, with their height above the sea:—Telegraph Hill, Killiney, 400 feet; N. W. side of Sugarloaf, county of Wicklow, 600 feet; south of Wicklow Head; between Enniscorthy and Wexford, 250 feet; Finglas, county of Dublin, 200 feet; Clane, county of Kildare; Naas, 380 feet; between Athy and Castlecomer, on the flanks of the elevated coal-field; and at Roscrea, 400 feet."

In a second paper by the same author (see "Journal of the Geological Society of Dublin, vol. iii., p. 130), the previous list of marine shells in the county of Dublin is added to—"making in all twenty-six species."

Captain James, R. E. (now Sir H. James) gave a paper—"Notes on the Tertiary Deposits of the County Wexford" ("Journal of the Geological Society of Dublin," vol. iii., p. 195)—and mentions seventy-four species of marine shells, the highest of which "were found at an altitude of 400 feet on the side of Forth Mountain;" but these, as previously mentioned, he seems to consider, occur in Præglacial Drift.

Mr. Du Noyer (see "Journal of the Geological Society of Dublin," vol. iii., p. 225) found marine shells at different places in the cuttings for the Dublin and Drogheda Railway. At Skerries he mentions that "the railway cuts through an esker," and the calcareous clay overlying this sand and gravel contains many sea shells of the same species as those now living." He also says that at the twenty-six mile post, and near the Nanny Water, there are deposits "containing quantities of recent sea shells, bones of fish, teeth and bones of animal." (*Quere*, might not these be ancient kitchen middens?)

Dr. Kinahan (see "Journal of the Geological Society of Dublin," vol. viii., p. 87) is mentioned as having found marine shells in the drift at Bohernabreena, county of Dublin. Of these my colleague, Mr. W. H. Baily, says—"None of them are strictly Arctic, and most, if not all, are found in the seas round Ireland at the present day." It is not mentioned at what height these shells occur, but the gravels at Bohernabreena are between 400 and 450 feet above the sea level.

Some of these gravels may have been deposited towards the end or after the Esker Drift period, when the sea was losing its Arctic character.

In the counties of Limerick and Galway, at low levels, there are what seem to be ancient sea beaches; but as they are on lower ground than that occupied by the eskers, they seem to me to be more recent, and therefore will not be further mentioned in these Notes; but I hope to describe those found in the county of Galway in a forthcoming Memoir of the Geological Survey.

Aughta and the Burren Hills, also in valleys in Yar-Connaught, and in the plains of Mayo. In the Scariff valley they coincide with the fall of the valley, and lie in the direction that the secondary striæ ought to run, and the same thing can be said of the part of the valley of the Shannon south of Killaloe. Mr. Close has recorded them in the county of Dublin as running in the same direction as striæ; but the latter he seems to consider as primary.

Some of the foregoing theories coincide with those of previous writers, but many I believe are new, and are based on personal observation. Possibly I may have been anticipated by observers whose works have not come under my notice.

XXXVI.—Notes on Animal Mechanics. By the Rev. Samuel Haughton, M. D., Fellow of Trinity College, Dublin.

[Read before the Royal Irish Academy, April 23, 1866.]

No. X.—Muscular Anatomy of the Emu (*Dromæus Novæ Hollandiæ*).

I am indebted to the kindness of Mr. Thomas Moore, Curator of the Derby Museum, of Liverpool, for the opportunity of dissecting a fine male specimen of the Emu (*Dromæus Novæ Hollandiæ*). This bird was sent to me from London (1865); and, having reached Dublin two days after death, was quite fresh, and in fine condition for dissection. On inspection it presented tubercles of the liver (Farre's?), an enormous developement of omental fat, and fibrinous clots, partly melanotic, in all its arteries.

I had also, through Professor Huxley, applied to the Council of the Zoological Society of London, for permission to dissect the muscles of the Ostrich, Emu, or Cassowary, in case such birds should die in their Gardens, and their bodies not be more favourably disposed of. In consequence of this application I received, 27th of April, 1866, the second Emu described in this note, which proved to be a larger and finer bird than the first; and I beg leave to take the present opportunity of returning my thanks to Professor Huxley, to Dr. Sclater, and to Dr. Murie, of the London Gardens, for the kindness with which they aided me in my attempt to procure specimens of these rare birds for the purposes of scientific research.

The examination of the muscles of these two Emus afforded the following results:—

A.—*Muscles of the Hip Joint.*

1. *M. psoas magnus*, ...	none.	
2. *M. iliacus*, ...	none.	
3. *M. pectinæus*, ...	none.	
4. *M. adductor brevis*, ...	none.	
5. *M. adductor magnus* (Fig. 28, *ad. mg.*), .	3·4	4·30 oz.
,, ...	5·2	

Takes its origin from the lower border of the ilium (postacetabular), and from the upper margin of the ischium, round the ischiadic foramen, and from the membrane of that foramen (y), Fig. 28, *ad. mg.* The greater part of this muscle $\left\{\begin{matrix}2\cdot7\\4\cdot7\end{matrix}\right\}$ 3·7 oz., is inserted by a strong flat tendon into the top of the linea aspera; and the rest is digastric (becoming tendinous as it passes behind the hip joint), and inserted into the linea aspera of the upper half of the thigh, as far down as the commencement of the *M. semi-membranoso accessorius;* it overlies the *adductor longus.*

$$\left.\begin{array}{ll}\text{6. \textit{M. obturator externus},} \;.\;.\;.\;.\;.\;.\;.\;.\;. & 1\cdot4\\ \quad\quad ,, \quad\;.\;.\;.\;.\;.\;.\;.\;.\;. & 1\cdot7\end{array}\right\}\;.\;.\;\; 1\cdot55\text{ oz.}$$

This muscle (which probably corresponds with the *obturator externus* of Mammals) arises from the *inner* surface of the bony rim of the ischiadic foramen (y), and its tendon passes with that of the *obturator internus* through the obturator tendinal foramen (x), and is inserted, after receiving the tendon of the *posterior gemellus,* No. 7, into the lower depression (Fig. 29. *o. e.*), marked on the outer side of the head of the femur.

$$\left.\begin{array}{ll}\text{7. \textit{M. gemellus posterior},} \;.\;.\;.\;.\;.\;.\;. & 0\cdot15\\ \quad\quad ,, \quad\;.\;.\;.\;.\;.\;.\;. & 0\cdot20\end{array}\right\}\;.\;.\;\; 0\cdot18\text{ oz.}$$

Origin very small, and near the acetabulum, from the outer side of the head of the obturator membrane (z). Both *gemelli* are found in the Emu; the *posterior* attaching itself to the tendon of the analogue of the *obturator externus,* and the *anterior* to the tendon of the true *obturator internus.*

$$\left.\begin{array}{ll}\text{8. \textit{M. adductor longus},} \;.\;.\;.\;.\;.\;.\;.\;.\;. & 2\cdot1\\ \quad\quad ,, \quad\;.\;.\;.\;.\;.\;.\;.\;.\;. & 3\cdot4\end{array}\right\}\;.\;.\;\; 2\cdot75\text{ oz.}$$

Arises from the lower border of the ischium (Fig. 28, *ad. l.*), below the inferior margin of the *adductor magnus;* and is inserted into the inner edge of the condyloid pit of the femur, and into the crucial ligament of the inner condyle. This muscle was originally double, and is folded on itself; its fibres were pale and fatty in both specimens.

$$\left.\begin{array}{ll}\text{9. \textit{M. obturator internus},} \;.\;.\;.\;.\;.\;.\;.\;.\;. & 2\cdot5\\ \quad\quad ,, \quad\;.\;.\;.\;.\;.\;.\;.\;.\;. & 3\cdot3\end{array}\right\}\;.\;.\;\; 2\cdot90\text{ oz.}$$

Arises from the inner side of the bony rim of the obturator foramen (z), and from its membrane, and is inserted (Fig. 29, *o. i.*) into the upper depression at the top of the back of the outer side of the head of the femur. The *anterior gemellus* is included in the weight of the *obturator internus.*

$$\left.\begin{array}{ll}\text{10. \textit{M. agitator caudæ et tensor vaginæ femoris},} & 11\cdot9\\ \quad\quad\quad\quad\quad\quad\quad\quad ,, & 18\cdot8\end{array}\right\}\;.\;.\;\; 15\cdot35\text{ oz.}$$

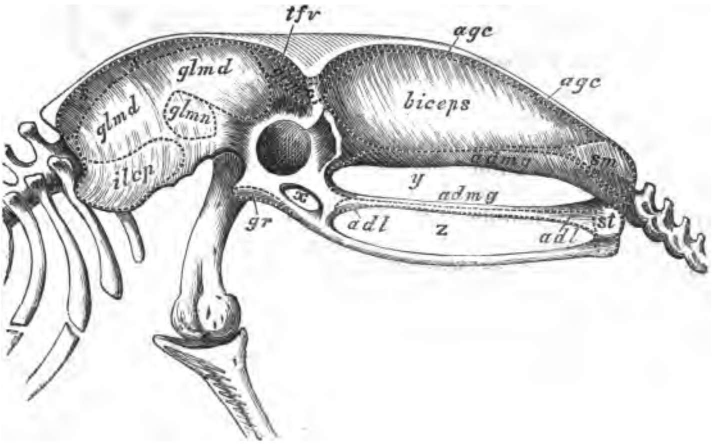
This combined muscle takes its origin by fascia, from the superior edge of the ilium in front of the acetabular prominence (Fig. 28, *t. f. v.*), and from the superior post acetabular edge of the ilium by fleshy fibres (Fig. 28, *ag. cd.*); and is inserted into the strong fascia overlying the knee on its outer side, and by a fleshy union and common tendon with the *vastus externus.*

The pre-acetabular muscle (*t. f. v.*) weighs. . 3·5 } . . 4·25 oz.
and is inserted into the fascia of the knee, . 5·0 }

The post-acetabular muscle (*ag. c.*) weighs . 8·4 } . . 11·10 oz.
" . . . . 13·8 }

and passes directly into the tendon of the vastus externus.

Fig. 28.



y, Ischiadic foramen. *z*, Obturator foramen. *x*, Tendinal foramen.

11. *M. glutæus maximus*, ... 1·0 } . . 0·95 oz.
" . . . . 0·9 }

The *gl. max.* takes its origin below that of the *ten. fem. vag.* and *agit. caudæ*, by fleshy fibres from a short space in front of and behind the acetabular prominence of the ilium (Fig. 28, *gl. mx.*).

12. *M. glutæus medius*, ... 5·1 } . . 5·65 oz.
" . . . . 6·2 }

The origin and insertion of this muscle are marked in Figs. 28, 29—*gl. md.*

13. *M. glutæus minimus*, ... 0·2 } . . 0·20 oz.
" . . . . 0·2 }

The origin and insertion of this muscle are marked in Figs. 28, 29, *gl. mn.*

14. *M. glutæus quartus* (*ilio-capsularis*), . . 1·1 } . . 1·15 oz.
" . . 1·2 }

Origin and insertion marked in Figs. 28, 29, *il. cp.*

B. *Muscles of the Knee Joint.*

1. *M. biceps femoris,* . . . . 9·4 } . . 10·90 oz.
" . . . . 12·4 }

Takes its origin from the large concave post-acetabular surface of the ilium, marked in Fig. 28; and is inserted by a round tendon passing through a looped pulley placed at the inner side of the outer head of *gastrocnemius* and outer condyle of the femur, into the large tubercle of the fibula, at its upper point of trisection.

2. *M. semimembranosus,* 4·4 } . . 5·80 oz.
" 7·2 }

The *semimembranosus* arises from the posterior margin of the ilium, adjoining the ischium (Fig. 28, *s. m.*), and from the sides of the 1st, 2nd, and 3rd caudal vertebræ; and flows freely over the posterior margin of the ischium (*s. t.*), and is inserted by means of a pinnæform tendon (shown at *s. m.* and *ac.* Fig. 30) formed with the help of the *accessorius,* into a final flat tendon forming one of the heads (β) of the *gastrocnemius,* on the inner side.

3. *M. semimembranoso-accessorius,* . . 0·6 } . . 0·70 oz.
" . . 0·8 }

This muscle is shown in Fig. 30, *ac.*

Fig. 29.

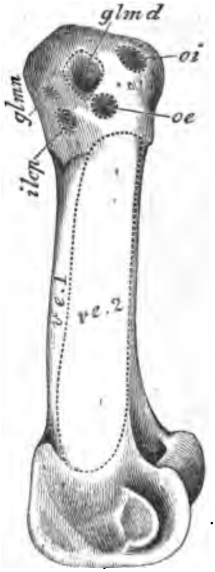
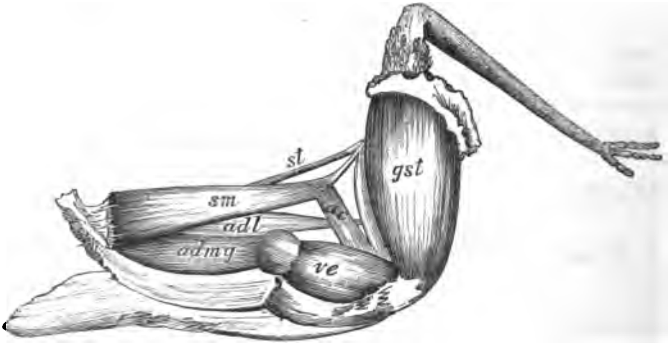


Fig. 30.



Arising from the lower half of the linea aspera, and from the back of condyloid pit at the inner condyle, and inserted into the pinnæform tendon of the *semimembranosus*. It will be observed that the plane of the *semi. m.* lies exterior to those of the *semitendinosus* and *adductores magnus* and *longus*.

4. *M. semitendinosus*, ... 1·0
,, ... 1·8 } . . 1·40 oz.

Arises from the posterior ends of the ischium and pubes (Figs. 28 and 30, *s. t.*), and terminates partly in a delicate tendon running into the tendon of the *plantaris*, and partly in a tendon inserted into the side of the tibia (1½ inch down).

5. *M. gracilis* (A), ... 1·0
,, ... 1·9 } . . 1·45 oz.
,, (B), ... 0·9
,, ... 1·1 } . . 1·00 oz.

There are two muscles in the Emu, neither of which are entitled to be regarded as *pectinæus* or *adductor brevis*, and both present certain analogies with *gracilis*. I shall regard them as *gracilis* (A), and *gracilis* (B).

(A). Takes its origin from the anterior spine of the pubes, and a line two inches in length behind it on the pubes (Fig. 28, *gr.*); and is inserted by a line three inches long into the edge of the inner border of the *vastus internus* (1) at its lower extremity.

(B). This muscle is double headed; one head being supplied from the pubic bone, immediately behind the anterior spine; and the other head taking its origin from the upper inch of the linea aspera of the femur; the tendon of the united muscle is strong and flat, and is inserted into the inner side of the head of the tibia.

6. *M. sartorius*, ... 6·2
,, ... 9·4 } . . 7·80 oz.

Its origin is marked Fig. 28, *s. s.*, and its insertion is made by a flat tendon into the inner side of the head of the tibia.

7. *M. rectus femoris* (Qu. *gracilis* (A) or (B)), ... *none.*
8. *M. vastus externus*, No. 1, ... 7·2
,, ... 10·0 } . . 8·60 oz.

Takes its origin all round the rim of *vastus externus* (2), which is completely covered by it, and from the surface of the outer front of the femur marked in Fig. 29, *v. e.* 1; and is inserted into the cartilaginous patella, like the ordinary *rectus femoris*, but rather towards the outer side.

9. *M. vastus externus*, No. 2, ... 0·80
,, ... 1·20 } . . 1·00 oz.

Takes its origin from the surface marked on the outer side of the femur Fig. 29, *v. e.* 2; and is inserted by means of a strong tendon (passing under the outer head of the *gastrocnemius*, and under the muscular head of the *flexor perforatus digiti interni*, and of the *flexor secundus perforatus digiti medii*), into the outer tubercle of the tibia. Its tendon of insertion passes over the muscular head of the *flexor perforatus digiti externi*.

10. *M. vastus internus*, No. 1,	1·1	1·40 oz.
,,	1·7	

Has an origin similar to that in the Ostrich, and is inserted into the inner side of the cartilaginous patella.

11. *M. vastus internus*, No. 2,	1·5	1·70 oz.
,,	1·9	

This muscle is composed of three distinct parts, occupying the lower, middle, and upper thirds of the femur on its inner aspect; these parts terminate in distinct tendons, which cross each other, the upper and lower passing to the lateral tubercle and head of tibia next inner condyle, while the middle tendon is attached between them to the tibia and to the fascia covering the patella.

12. *M. poplitæus*,	0·3	0·35 oz.
,,	0·4	

Inserted 1½ inches down tibia.

C. *Muscles of the Heel and Foot.*

1. *M. gastrocnemius*,	24·4	28·00 oz.
,,	31·6	

This muscle consists of four distinct parts—

a,	9·6	10·60 oz.
	11·6	
β,	1·2	1·35 oz.
	1·5	
γ,	1·1	1·25 oz.
	1·4	
δ,	12·5	14·80 oz.
	17·1	
Total,		28·00 oz.

a. This portion takes its origin from the outer condyle (having behind its head the pulley through which the tendon of the *biceps* passes), and from the fascia covering the patella.

β. This part of the muscle is inseparably connected with the muscle accessory to the *semi-membranosus*; and, in a mechanical point of view, the *semi. memb.*, and its accessory muscle, aid the *gastrocnemius*, by their insertion into the head of (*β*), which arises from the inferior prolongation on the femur, of the line of origin of the *accessorius*.

γ. This branch of the *gastrocnemius* arises from the condyloid pit of the femur, by a beautiful round cord-like tendon.

δ. This arises from the whole inner side of the head of the tibia, and from the side of the patella.

2. *M. solæus*, ... 10·0 }
,, ... 13·0 } . 11·50 oz.

Takes its origin from the anterior edge of the fibula, from the outer side of the tubercle of the tibia, from the whole outer surface of the ligamentum patellæ, and from the fascia covering the *tibialis anticus*. Its insertion is double; by a broad tendon into the *ligamentum calcis*, which acts as a patella to the heel, and by a narrower tendon, which, at six inches below the first insertion, is inserted into the outer side of the tendon of the first *flexor perforatus digiti medii*.

3. *M. plantaris*, ... 0·30 }
,, ... 0·21 } . . 0·26 oz.

Arises from the back of the inner cartilage of the knee joint, and is inserted into the inner side of the *ligamentum calcis*, or patella of the heel.

N. B.—The tendon of this little muscle receives a large portion of the *semitendinosus*.

4. *M. flexor perforatus primus digiti medii*, . 1·8 }
,, . 3·1 } . . 2·45 oz.

Arises by two heads, from the patellar fascia covering the outer condyle, and by a long tendon, terminating in the condyloid pit; and is inserted by a perforated tendon on both sides of the distal ends of the first phalanx of the middle toe.

The tendon of this muscle is united by means of a cross slip (intended to produce unity of action) with that of the next muscle, at a point opposite the metatarso-phalangeal articulation.

5. *M. flexor perforatus secundus digiti medii*, 1·3 }
,, 1·6 } . . 1·45 oz.

Arises from the outer side of the ligamentum patellæ, overlying the tendon of *vastus externus* (2); and is inserted by a perforated tendon into both sides of the distal end of the second phalanx of the middle toe.

6. *M. flexor perforatus digiti externi*, . . 1·3 }
,, . . 1·6 } . . 1·45 oz.

Arises, by a double head, from the external ligament of the knee joint, underlying the tendon of *vastus externus* (2), and from the condyloid pit; and is inserted by a perforate tendon into both sides of the distal end of the first phalanx of the outer toe.

N. B.—The tendon of this muscle, before it reaches the heel, passes through the tendon of the second perforate tendon of the middle toe, for a distance of three inches, as if in a sheath.

7. *M. flexor perforatus digiti interni*, . .	0·15	. . 0·18 oz.
,, . .	0·20	

This little muscle arises from the outer fascia of the knee joint, overlying the tendon of *vastus externus* (2), and is inserted at both sides of the distal end of the first phalanx of the inner toe.

8. *M. flexor hallucis longus*, ...	0·4	. . 1·00 oz.
,, ...	0·6	

Arises from the back of both heads of the *flexor perforatus* of the middle toe, and is inserted on the outer side of the near end of first phalanx of inner toe.

9. *M. flexor communis perforans*, ...	2·4	. . 3·20 oz.
,, ...	4·0	

This muscle is formed of two totally distinct muscles, whose separate tendons unite into a common tendon two-thirds down the cannon bone.

a, ...	0·7	. . 0·90 oz.
. . . .	1·1	
β, ...	1·7	. . 2·30 oz.
. . . .	2·9	
Total, ...		3·20 oz.

a. Arises by a double head from the backs of both condyles of the femur; its tendon passes through a sheath formed in the *ligamentum calcis*, on the outer side of the inferior ridge of the cannon bone.

β. Arises from the whole posterior surfaces of the tibia and fibula, except the portion of the tibia occupied by the *poplitæus*.

N. B.—The united tendon of the *perforans* bifurcates, at the metatarso phalangeal articulation, to the ungual phalanges of all the toes, and at its point of bifurcation a small auxiliary muscle (0·05 oz.) unites the tendon with the posterior border of the sesamoid ligament, under the groove of which the common tendon passes.

10. *M. tibialis anticus*, ...	4·6	. . 4·85 oz.
,, ...	5·1	

This muscle is bicipital, and arises from the anterior and outer tubercles of the tibia and the surface of bony ridge joining them; and (as in the Dog and other animals) by a long, beautiful, round rope-like tendon, from the point of the outer condyle, inside the knee joint.

It is inserted into the near end of the cannon bone, in front of the heel, first passing under a "dead eye" ligamental bolt on the front of the tibia.

11. *M. extensor communis digitorum longus*,	1·2	. . 1·30 oz.
,,	1·4	

Arises from the front of the tibia, on the outer side of the ridge running down from the anterior tubercle, and is inserted by tendons distributed to the ungual phalanges of all the toes, and to the tendinous sheath of the first phalanx of the middle toe.

12. *Flexor digitorum brevis et abductor digiti externi*, ... 0·1 }
,, ... 0·1 } . . 0·10 oz.

The *flexor brevis* arises from two inches of the outer and back surface of the near end of the cannon bone, and unites with the *abductor* by a long slender tendon running the whole length of the cannon bone; the *abductor* arises from the outer and under side of the distal end of that bone, for a space of 1½ inch, marked off by a slight bony ridge; and the common tendon is inserted into the outer side of the near end of the first phalanx of the outer toe.

13. *Abductor hallucis et extensor digitorum brevis*, ... 0·2 }
,, 0·2 } . . 0·20 oz.

These muscles are inseparable; and the *abductor* arises from an inner surface of the under and distal end of the cannon bone, marked off by a slight bony ridge, like that of the *abductor minimi digiti*, while the *extensor* takes its origin by a thin sheet of muscular fibres from the whole breadth of the upper surface of the distal end of the cannon bone, for the space of one inch.

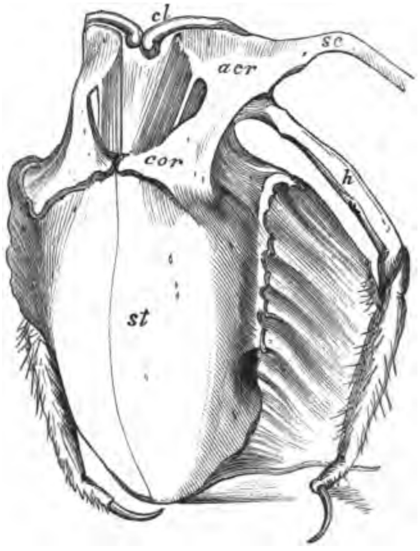
D.—*Muscles of the Wings.*

The anterior limbs in the Emu are much smaller than in the Ostrich and Rhea, and are hidden almost completely by the plumage. The following sketch (Fig. 31) gives a very good idea of the relative proportions of the bones of the wing and sternum; and in it, the initial letters indicate the parts.

1. *M. trapezius*,
0·27 }
0·28 } 0·28 oz.

Takes its origin from the first, second, and third ribs, and subcutaneously, from the skin covering them; and is inserted into the clavicle, acromion ridge, and anterior two-thirds of the scapula. Its posterior fibres slant forwards.

Fig. 31.



sc., Scapula.
cl., Clavicle.
acr., Acromion.
cor., Coracoid.
st., Sternum.
h., Humerus.

2. *M. rhomboideus*, ... 0·12 } . . 0·12 oz.
   ,, ... 0·11 }

Arises from the third rib, and space between it and second rib; and is inserted into the under surface of the posterior third of the scapula; its fibres slant backwards.

3. *M. latissimus dorsi et teres major*, . . . 0·13 } . . 0·14 oz.
   ,, . . . 0·15 }

Occupies its usual position, passing over the posterior border of the scapula, and has also a subcutaneous origin; the *lat. dorsi* arises from the fourth rib, and forms the posterior slip of the whole conjoined muscle; the *teres major* arises from the outer side of the posterior half of the scapula. These muscles are inserted by a common tendon into their usual place at the back of the humerus.

4. *M. pectoralis* (*major et minor*), ... 0·05 } . . 0·07 oz.
   ,, ... 0·09 }

This sheet of muscle takes origin from the front and edge of the sternum and from the sternal ribs (two inches), and has the usual insertion; it is an *adductor humeri.*

5. *M. pectoralis secundus*, ... 0·09 } . . 0·065 oz.
   ,, ... 0·04 }

Arises in a thin sheet from the lower border of the acromion, from the surface of the clavicle, and from the coraco-clavicular membrane, and terminates in a tendon passing over the groove in the upper end of the coracoid, to be inserted into the top of the pectoral ridge of the humerus;—it is a *levator humeri.*

6. *M. deltoideus*, ... 0·05 } . . 0·065 oz.
   ,, ... 0·08 }

Arises from the acromial end of the scapula, at the coraco scapular line of junction, and is inserted into the outer side of the pectoral ridge.

7. *M. coraco-brachialis*, ... 0·05 oz.

Arises from the outer edge of the coracoid, and is inserted into the upper and inner fourth of the back of the humerus.

8. *M. triceps humeri*, ... 0·05 } . . 0·065 oz.
   ,, ... 0·08 }

Has three heads—

α. cutaneous (*panniculus carnosus*).
β. long head from scapula in usual place.
γ. fleshy, from the inner and back side of the humerus.

9. *M. supra et infra spinatus*, ... 0·01 } . . 0·01 oz.
   ,, ... 0·01 }

Arises from one inch of the lower edge of scapula, close to glenoid, and is inserted into the inner side of the back of the head of the humerus, in front of the insertion of the *subscapularis*.

10. *M. subscapularis*,	0·01	0·01 oz.
„	0·01	

Origin from the inner and lower border of the scapula, half an inch from glenoid; inserted into the top and back of the inner side of the head of the humerus, inside the insertion of the *spinati*.

10. *M. serratus magnus*,	0·14	0·115 oz.
„	0·09	

Arises from second and third ribs in the usual manner, and is inserted as usual.

11. *M. biceps humeri*,	0·01	0·025 oz.
„	0·04	

XXXVII.—NOTES ON ANIMAL MECHANICS. By the Rev. SAMUEL HAUGHTON, M. D., Fellow of Trinity College, Dublin.

[Read before the Royal Irish Academy, April 23, 1866.]

No. XI.—MUSCULAR ANATOMY OF THE RHEA (*Struthio Rhea*).

I AM indebted to Mr. Thomas Moore, Curator of the Derby Museum of Liverpool, for the opportunity of dissecting the Rhea, which forms the subject of this notice. It was a male bird, and seemed to be in good condition.

A.—*Muscles of the Hip and Knee Joints.*

1. *M. psoas magnus*,	*none.*
2. *M. iliacus*,	*none.*
3. *M. pectinæus*,	0·12 oz.

Arises immediately in front of the acetabulum (Fig. 32, *p.*), and is inserted into the top of the linea aspera.

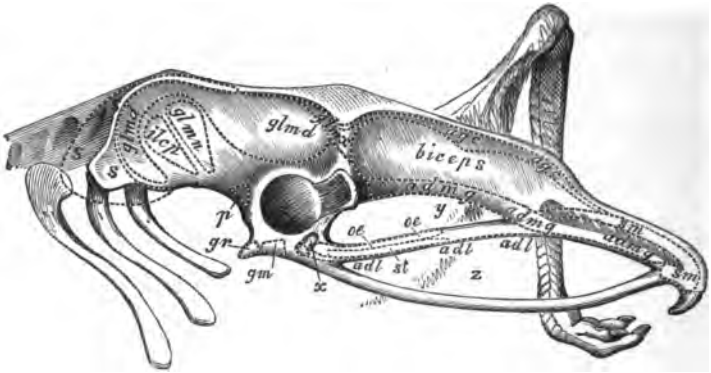
4. *M. adductor brevis*,	*none.*
5. *M. adductor magnus*,	2·60 oz.

Arises from the lower border of the ilium, forming the upper margin of the ischiadic foramen, *y* (Fig. 32), and the prolongation of this bone backwards in conjunction with the ischium (Fig. 32, *ad. mg.*); it is partly inserted into the top of the linea aspera, and partly into the tendon of the *semimembranosus* that is attached to the femur; the tendinous slip that joins these muscles helps them both to pull on the same tendon at the back of the femur.

6. *M. obturator externus*, ... 0·51 oz.

Arises from the upper margin of the anterior half of the ischium (Fig. 32, *o. e.*), and from the membrane of the ischiadic foramen, and is inserted by means of a strong tendon (Fig. 33, *o. e.*) into the back of the outer side of the head of the femur, behind the *glutæus medius.*

Fig. 32.



x, Tendinal foramen. *y*, Ischiadic foramen. *z*, Obturator foramen.

7. *M. obturator internus*, ... 2·25 oz.
8. *M. gemellus anterior*, ... 0·08 oz.

Arises from the point marked (Fig. 32, *gm.*) in front of the tendinal foramen *x*; and is inserted into the back of the femur (Fig. 33, *gm.*) behind the tendon of the *M. obturator.*

9. *M. adductor longus*, ... 1·00 oz.

Arises by fascia from the anterior two-thirds of the lower border of the ischium (Fig. 32, *ad. l.*), and is inserted into the lower half of the linea aspera and into the tibia.

N. B.—This muscle is double; its posterior portion weighs 0·14 oz., and is inserted into the lower third only of the linea aspera; the anterior portion is inserted as above described.

10. *M. agitator caudæ et tensor vaginæ femoris*, ... 6·02 oz.

Arises by slip of fascia from the præ-acetabular edge of the ilium overlying the posterior portion of the *glutæus medius*, and from the postacetabular edge of the ilium overlying the *biceps femoris.* It is inserted partly by fascia into the outer side of the patella, and partly into the lower margin of the *vastus externus* (1).

11. *M. glutæus maximus*, ... 0·23 oz.
Arises from the line marked (Fig. 32, *gl. mx.*) at the acetabular prominence of the ilium.

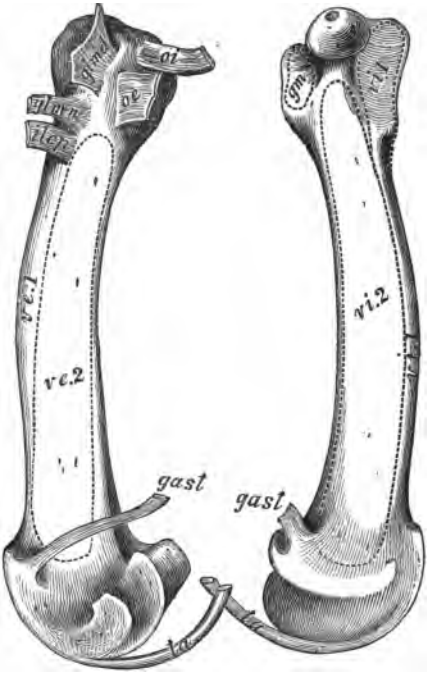
12. *M. glutæus medius*, 2·05 oz.
Its origin and insertion are marked in Figs. 32 and 33, *gl. md.*

13. *M. glutæus minimus*, 0·25 oz.

14. *M. glutæus quartus* (*iliocapsularis*), 0·23 oz.
The origin and insertion of these muscles are marked in Figs. 32 and 33, *gl. mn.* and *il. cp.*

15. *M. biceps femoris*, 3·80 oz.
The origin of this muscle on the postacetabular surface of the ilium is marked in Fig. 32; and it is inserted by the usual pulley at the back of the outer head of the *gastrocnemius* into the tubercle of the fibula.

Fig. 33.



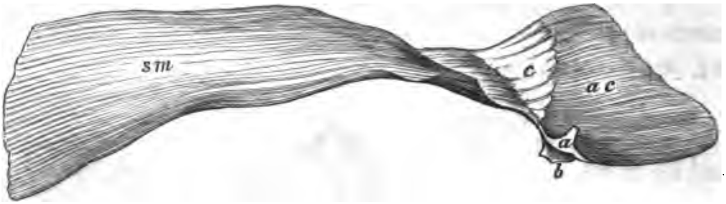
16. *M. semimembranosus*, 2·30 oz.
Arises from the posterior portions of the ilium and ischium (Fig. 32, *s. m.*); and is inserted partly by a tendon into the top of the linea aspera, and partly by a tendon, which is aided (as in the Emu) by an accessory muscle, and which itself has a double insertion by means of two flat tendons into the head of the inner *gastrocnemius*, and into the middle point of the broad insertion of the *semitendinosus* into the tibia.

N. B.—This muscle, as already noticed, is connected with the *adductor magnus* by a tendinous slip.

17. *M. semimembranoso accessorius*, ... 0·50 oz.

This muscle is shown in Fig. 34, and its general arrangement and connexion with the *semimembranosus* are similar to those already described in the case of the Emu.

Fig. 34.



s. m.,	*Semimembranosus.*	*a.,*	Portion of tendon ending in *gastrocnemius.*
ac.,	*Accessorius.*	*b.,*	Portion of tendon ending in tibia.
c.,	Common tendon.		

18. *M. semitendinosus,* . . . . 0·71 oz.

Arises from the lower margin of the anterior half of the ischium (Fig. 32, *s. t.*), and is inserted by means of a broad tendon into the fascia of the upper and inner part of the leg, with a slip passing on to the heel.

19. *M. gracilis,* . . . . 0·12 oz.

Arises from the anterior spine of the pubes (Fig. 32, *gr.*), and terminates in a slender tendon which passes over the patella, from within outwards, across the knee joint under the anterior head of the *gastrocnemius* and *solæus,* outwards and downwards to the calf of the leg, being strapped down by the tendon of the *biceps* at its insertion into the fibula, at one inch below which it expands into a fan-shaped tendon spread over the back of the fascia, enclosing the first *flexor perforatus digiti medii* and the *flexor perforatus digiti externi;* this fan-shaped expansion of the tendon of *gracilis* is also connected by means of an auxiliary tendon passing backwards, with the inner side of the head of the second *flexor perforatus digiti medii.* The three tendons of the flexors just named, and so placed in relation with the *gracilis,* pass together into the toes.

N. B.—The *gracilis* muscle in the Rhea performs the mechanical duty assigned by me to the *rectus femoris* in the Ostrich, and serves to bring into simultaneous action all the flexors of the foot and extensors of the leg.

20. *M. sartorius,* . . . . 2·80 oz.

Arises from the anterior surface of the ilium (Fig. 32, *s. s.*), and from the backs of the last two ribs overlying the *glutæus medius;* and is inserted by a broad tendon into the head of the tibia.

21. *M. rectus femoris,* . . . . *none.*

22. *M. vastus externus* (1), (Fig. 33, *v. e.* 1), ... 5·07 oz.

Origin and insertion as in Emu.

23. *M. vastus externus* (2), (Fig. 33, *v. e.* 2), ... 0·40 oz.

As in the Emu, with its tendon passing under the head of the *gastrocnemius* to be inserted into the outer tubercle of the tibia.

N. B.—This tendon binds down the tendon of the *gracilis* after it has crossed in front of the knee joint.

24. *M. vastus internus* (1), (Fig. 33, *v. i.* 1), ... 0·95 oz.

Origin and insertion as in the Emu.

25. *M. vastus internus* (2), (Fig. 33, *v. i.* 2), ... 0·95 oz.

Generally as in the Emu, but not so easily divisible into three portions; inserted into the inner head of the tibia.

26. *M. poplitæus*, ... 0·21 oz.

B.—*Muscles of the Ankle and Toes.*

1. *M. gastrocnemius*, ... 11·16 oz.

α, Outer head, as in the Emu, . 2·81
β, Origin from condyloid pit, . . 1·74
γ, Inner head, ... 6·61

11·16 oz.

γ. This portion of the *gastrocnemius* takes its origin from the back of the inner condyle, from the inner surface of the anterior tubercle, and from the whole head of the tibia, as well as from the side of the ligamentum patellæ.

2. *M. plantaris*, ... 0·50 oz.

Arises from the posterior ligament of the knee joint, on the inner side, and is blended at its insertion with the inner surface of the tendo Achillis formed by the *gastrocnemius*.

3. *M. solæus*, ... 4·12 oz.

Origin and insertion as in the Emu. Its tendon forms the anterior side of the sheath for the tendons of the heel, while the tendon of the *gastrocnemius* forms the posterior side; the secondary slip of the tendon of the *solæus* joins the side of the tendon of the first *flexor perforatus digiti medii* at five inches below the heel joint.

4. *M. flexor perforatus primus digiti medii*, ... 0·74 oz.

Inserted into the near ends of the first and second phalanx of the middle toe.

5. *M. flexor perforatus digiti externi*, ... 0·54 oz.

Inserted into the distal ends of the first phalanx of the outer toe.

6. *M. flexor perforatus secundus digiti medii*, ... 0·27 oz

Arises from the outer ligament of the knee joint, and is inserted into the near ends of the ungual phalanx of the middle toe.

N. B.—The tendons of the first and second flexor of the middle toe are free in the Rhea, and not united by a cross slip, as in the Emu.

7. *M. flexor perforatus digiti interni*, ... 0·23 oz.

Arises from the fascia covering the inner surface of *solæus*, and is inserted into the near ends of the first phalanx of the inner toe.

8. *M. flexor hallucis longus*, ... 0·10 oz.

Arises from the outer ligament of the knee joint, and is inserted into the near ends of the ungual phalanx of the inner toe, the largest tendon being distributed to the outer side of the toe.

9. *M. flexor communis perforans*, ... 1·22 oz.

This muscle is formed, as in the Emu, of two distinct muscles, whose tendons unite halfway down the cannon bone.

α. This is a double-headed muscle, taking its origin from the backs of both condyles, ... 0·24 oz.
β. Arises from the whole posterior surfaces of the tibia and fibula, ... 0·98 oz.

1·22 oz.

10. *M. tibialis anticus*, ... 1·52 oz.

A two-headed muscle, as in the Emu, taking one origin from the outer and anterior tubercles of the tibia, and another by a round tendon, inside the knee joint, from the anterior surface of the outer condyle of the femur.

11. *M. extensor digitorum communis*, ... 0·63 oz.

Arises from the anterior surfaces of the tibia and fibula, and is inserted into the backs of the ungual phalanges, and into the common sheath of the back of the foot.

C.—*Muscles of the Wings.*

The wing of the Rhea, like that of the Ostrich, which it resembles in so many other respects, is much more fully developed than that of the Emu, as may be seen from the accompanying sketch (Fig. 35).

1. *M. trapezius*, ... 0·08 oz.

Arises from the transverse processes of the last cervical vertebra, and from the first rib, and is inserted into the acromial ridge at the top of the scapula.

2. *M. rhomboideus*, ... 0·02 oz.

Arises from the side of the third dorsal vertebra, and is inserted into the posterior inch of the back of the scapula.

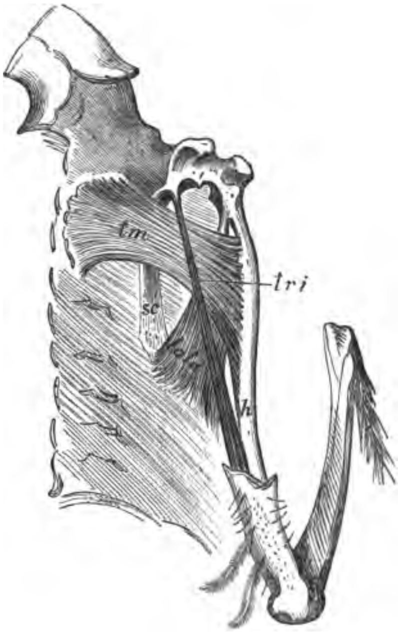
3. *M. latissimus dorsi*, ... 0·15 oz.

4. *M. teres major*, ... 0·20 oz.

These muscles are very remarkable, and are well shown in Fig. 35 (*lat. d.* and *t. m.*). The *lat. dorsi* takes its origin from the central portion of the fourth rib (1½ inch), and is inserted into the top and back of the humerus, where it acts nearly as an opponent of the second pectoral, as a depressor of the arm.

The *teres major* takes its origin from the spinous processes of the first and second dorsal vertebræ, and from the interspinous ligament, and is inserted broadly (half an inch) into the middle of the deltoidal ridge, lying under the deltoid itself.

Fig. 35.



5, 6. *M. pectoralis major et minor*, . . 0·27 oz.

Arises from side of top of sternum and from upper sternal ribs, and is inserted into the pectoral ridge of the humerus, and into the sheath covering the *biceps humeri*.

7. *M. pectoralis secundus*, 0·37 oz.

Takes its origin from the coracoid bone, from the top of the sternum, and from the coraco-clavicular membrane; and is inserted into the top of the pectoral ridge.

N. B.—This muscle acts as a direct *levator humeri*, and its posterior fibres are continuous with those of the *deltoideus*, which draws the humerus backwards and upwards.

8. *M. deltoideus externus*, ... 0·36 oz.

Takes its origin from the tip of the acromion, and from three-fourths of an inch of the scapula behind it; and is inserted halfway down the arm, along the back of the deltoidal ridge.

9. *M. coracobrachialis*, ... 0·16 oz.

Arises from the posterior edge of the coracoid, and is inserted into the triangular space lying inside the pectoral ridge on the head of the humerus.

10. *M. triceps humeri* (Fig. 35, *tri.*), ... 0·32 oz.

11. *M. supra et infraspinatus*, ... 0·08 oz.
Arises from the inferior surface of the whole acromion and top of the scapula, and is inserted into the lesser tuberosity.

12. *M. subscapularis*, ... 0·22 oz.
Arises from the whole lower and inner surface of the scapula, and is inserted into the back of the lesser tuberosity.

13. *M. serratus magnus*, ... 0·06 oz.
Arises from the first and second ribs.

14. *M. biceps humeri*, ... 0·15 oz.
Arises from the tip and posterior border of the coracoid, and is inserted into the tubercle of the radius.

N. B.—This muscle overlies the *coracobrachialis*.

XXXVIII.—NOTES ON ANIMAL MECHANICS. By the Rev. SAMUEL HAUGHTON, M. D., Fellow of Trinity College, Dublin.

[Read before the Royal Irish Academy, April 23, 1866.]

No. XII.—ON THE MUSCULAR ANATOMY OF THE IRISH TERRIER, AS COMPARED WITH THAT OF THE AUSTRALIAN DINGO.

THE anatomy of the Dog is so well known, that I have not attempted in the following account to do more than exhibit the relative weights of the corresponding muscles in four typical specimens, and have added a few explanatory notes respecting facts that I have not found recorded in the writings of other anatomists who have described the muscles of the Dog.

The first Dog mentioned was a long-legged Irish Terrier, with about one-eighth Bull blood, and was a well-known fighting dog, of light weight.

The second Dog was very similar, but had not been trained to fight; he was a good water dog, and frequently caught and ate water hens, hunting on his own account.

The third Dog was a Dingo, long resident in the Zoological Gardens of Dublin, and his death was occasioned by his own misconduct; having devoured his four pups for breakfast, he was called to account for his misbehaviour by the mother of the pups, who throttled him on the spot, being persuaded, as some thought, that if she did not anticipate him, he would have proceeded to devour herself next.

The fourth Dog described was a Greyhound bitch, of excellent running qualities.

A.—*Muscles of the Hind Legs.*

It will be seen from a comparison of all the muscles that the Dingo is closely related to the Irish Terrier, but differs widely from the Greyhound.

	IRISH TERRIER.		DINGO.	GREYHOUND.
	No. 1.	No. 2.		
	Oz.	Oz.	Oz.	Oz.
1. Psoas, 2. Iliacus,	0·82	0·85	1·12	2·07
3. Pectinæus,*	0·13	0·14	0·23	0·30
4. Adductor brevis,	0·11	0·14	0·25	0·34
5. Ad. magnus,	1·86	2·80	3·50	6·27
6. Obturator externus,	0·16	0·24	0·33	0·47
7. Ad. longus,	1·02	0·98	1·20	3·81
8. Quadratus femoris,	0·09	0·13	0·23	0·21
9. Obturator internus, &c.,	0·24	0·30	0·49	0·62
10. Agitator caudæ et 11. Glutæus maximus,	0·41	0·38	0·84	0·77
12. Tensor vaginæ femoris,	0·73	0·69	0·66	1·90
13. Glutæus medius,	1·40	1·56	2·22	3·38
14. Pyriformis,	0·16	0·20	0·26	0·28
15. Glutæus minimus,	0·17	0·20	0·30	0·35

16. *Gubernator caudæ*, part of the *intercostalis caudalis* (Greyhound), = 0·24 (as in Kangaroo) from interior of ilium behind acetabulum to costal processes of second and third caudals.

1. Biceps femoris,†	2·71	2·85	4·66	7·60
2. M. bicipiti accessorius,‡	—	—	0·10	0·12
3. Semimembranosus,	0·60	0·92	2·05	2·11
4. Semitendinosus,	0·90	1·10	1·81	3·18
5. Gracilis,	0·63	0·78	1·59	2·15
6. Sartorius,§	0·61	0·58 0·19	1·06 0.31	0·44 0·45
7. Rectus femoris,	0·77	0·83	1·42	2·31
8. Vastus externus,	1·50	1·61	3·01	5·01
9. Vastus internus,	0·74	0·87	1·54	2·67

1. Gastrocnemius,	1·21	1·72	2·40‖	1·28 1·87
2. Poplitæus,	0·11	0·11	0·15	0·30
3. Flexor dig. longus,	0·33	0·40	0·59	0·82
4. Flexor hallucis longus,**	0·04	0·06	0·10	0·15
5. Tibialis posticus,††	—	—	0·01	—
6. Flexor dig. brevis (perforatus),	0·01	—	—	—
7. Peronæus longus,	0·11	0·13	0·16	0·27
8. Peronæus brevis,	0·02	0·03	0·03	0·03
9. Peronæus tertius,	0·03	0·02	0·04	0 04

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* Inserted into the fascia covering the *vastus internus.*

† Inserted into the fascia above the knee, and two-thirds down the fibula, terminating in the *tendo Achillis*, as in the Lion; the posterior fibres form a ribbon-like slip, distinct from the main body of the muscle, and terminating directly in the calcaneum, forming the *M. bicipiti accessorius.*

‡ Takes its origin from the sacro-ischiadic ligament.

§ The *sartorius* in the Dog is double; the greater part being inserted one inch down the inner side of the leg, and the lesser part being inserted into the side of the patella; in the Greyhound these parts are equal.

‖ Outer head, 1·70 oz.; and inner head, 0·70 oz.

** Arises from the back of the outer head of the tibia, and is inserted into the side of the broad tendon of the *flex. dig. longus.*

†† Reduced to a shining tendon, with usual origin and insertion.

	IRISH TERRIER.		DINGO.	GREYHOUND.
	No. 1. Oz.	No. 2. Oz.	Oz.	Oz.
10. Tibialis anticus et Extensor hallucis longus, [a]	0·27	0·24	0·42	0·90
11. Extensor digitorum longus,[b]	0·30	0·28	0·37	0·68

B.—*Muscles of the Fore Legs.*

1. Trapezius clavicularis,[c]	0·47	0·49	0·70	0·71
2. Cleidomastoideus,[d]	0·46	0·47	0·69	0·61
3. Deltoideus clavicularis,	0·35	0·36	0·81	0·72
4. Trapezius scapularis,[e]	0·70	0·81	1·43	1·15
5. Omo-atlanticus,[f]	0·47	0·52	0·96	0·95
6. Rhomboideus,[g]	0·67	1·05	1·51	1·85
7. Serratus magnus,	2·23	2·74	3·84	4·50
8. Sternomastoideus,	0·64	—	1·00	1·38
9. Deltoideus scapularis,[h]	0·50	0·63	1·05	1·39
10. Latissimus dorsi,[i]	1·81	2·55	3·43	4·44
11. Teres major,	0·48	0·70	0·74	1·18
12. Subscapularis,	0·91	1·08	1·60	2·10
13. Pectoralis minor,	1·51	2·50	4·15	7·07
14. Pectoralis major,	0·83	1·10	1·92	1·97
15. Supraspinatus,	1·26	1·77	2·77	3·70
16. Teres minor,	—	0·08	0·10	0·14
17. Infraspinatus,	1·08	1·28	1·94	2·64
18. Coracobrachialis,	0·07	0·05	0·09	0·11
1. Triceps humeri,	3·85	4·85	8·23	10·89
2. Anconæus,	0·08	0·11	0·15	0·14
3. Biceps humeri,	0·45	0·48	0·85	1·15
4. Brachiæus (externus),	0·23	0·33	0·59	0·67
5. Pronator radii teres,	0·05	0·06	0·12	0·13
6. Flexor carpi radialis,[k]	0·07	0·10	0·16	0·21
7. Flexor dig. sublimis,	0·21	0·25	—	0·46
8. Flexor carpi ulnaris,[l]	0·31	0·43	0·79	0·61

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[a] A conjoined muscle, with two appropriate tendons inserted as usual.

[b] Arises by a round tendon inside the knee joint from the anterior surface of the outer condyle of the femur.

[c] Arises from the occipital ridge, and first to fifth cervical vertebra, and is inserted into the ligamental line that represents the clavicle.

[d] Arises from the mastoid process, and is inserted into the clavicular ligament.

[e] Arises from the dorsal vertebræ, and is inserted into the spine of the scapula.

[f] Arises from the transverse process of the atlas, and is inserted into the anterior part of the spine of the scapula.

[g] Including a slip from the occiput, as in the *Macacus nemestrinus*; it takes origin from all the cervical vertebræ and anterior half of the dorsal.

[h] Arises from the anterior extremity of the scapular spine, and from the fascia covering the anterior portion of the *infraspinatus* = *deltoideus externus* (Cuv.).

[i] Gives origin, near its insertion, to a fourth head of the *triceps*.

N. B.—There is also a cutaneous accessory.

[k] Inserted into the near end of the metacarpal of second finger (index).

[l] Consists of two distinct muscles, with double tendon-inserted into the pisiform bone.

	No. 2.	DINGO.
Condyloid head,	0·08	0·12
Olecranon head,	0·35	0·67
	0·43	0·79

	Irish Terrier. No. 1. Oz.	Irish Terrier. No. 2. Oz.	Dingo. Oz.	Greyhound. Oz.
9. Supinator radii longus,[m]	0·34	0·36	0·61	0·70
10. Extensor dig. commun.,[n]	0·12	0·17	0·21	0·30
11. Extensor carpi radialis,[o]	0·04	0·06	0·09	0·09
12. Extensor carpi ulnaris,[p]	0·11	0·16	0·23	0·34
13. Supinator radii brevis,	0·03	0·03	0·07	0·06
14. Flexor dig. profundus,	0·43	0·63	1·02	1·38
15. Extensor oss. met. pollicis,[q]	0·03	0·07	0·08	0·10
16. Pronator radii quadratus,[r]	0·04	0·06	0·11	0·12

XXXIX.—NOTES ON ANIMAL MECHANICS. By the Rev. SAMUEL HAUGHTON, M. D., Fellow of Trinity College, Dublin.

[Read before the Royal Irish Academy, April 23, 1866.]

No. XIII.—ON THE MUSCULAR ANATOMY OF THE BADGER.

THE muscles recorded in the present Note were observed in two fine specimens of the Badger (*Meles taxus*), male and female, which died in November and December, 1864, in the Gardens of the Royal Zoological Society of Ireland.

A.—*Muscles of the Hind Limb* (Male).

	Grs.
1. Sartorius,	235
2. Iliacus, 3. Psoas magnus,[s]	231
4. Pectinæus,	70
5. Adductor magnus,	374
6. Obturator externus,	110
7. Quadratus femoris,	44
8. Obturator internus, et gem.,	77
9. Glutæus maximus, et agitator caudæ,	88
10. Glutæus medius,	350
11. Pyriformis,	40
12. Glutæus minimus,	20
13. Glutæus quartus (ilio-capsularis),	20
14. Tensor vaginæ femoris,	70
15. Biceps femoris,	517
16. Bicipiti accessorius (as in Lion), (6 inches long, and ribbon-like),	25
17. Semimembranosus,	490
18. Semitendinosus,	260
19. Gracilis,	245
20. Rectus femoris,	250
21. Vastus externus,	385
22. Vastus internus,	105
23. Cruræus,	11

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[m] Inserted into near ends of index and middle metacarpals.

[n] Distributed chiefly to the little and ring fingers.

[o] Distributed below the tendons of the *ex. dig. com.* to the little and ring fingers.

[p] Inserted into the outer and near end of the metacarpal of the little finger.

[q] Inserted into the inner and near end of the metacarpal of the thumb.

[r] Extends along the whole length of the radius and ulna.

[s] *Psoas parvus* = 142 grs.

B.—*Muscles of the Fore Limb* (Female).

	Grs.		Grs.
1. Trapezius et deltoideus clavicularis vel internus,	335	8. Teres major,	94
2. Rhomboideus (with occipital slip),	276	9. Subscapularis,	231
3. Serratus magnus,	473	10. Pectoralis minor,	297
4. Sternomastoideus,	210	11. Pectoralis major,	210
5. Cleidomastoideus,	85	12. Deltoideus scapularis (externus),	88
6. Omo-atlanticus,	100	13. Supraspinatus,	308
		14. Infraspinatus,	220
		15. Triceps humeri,	858
7. Latissimus dorsi,	652	16. Biceps humeri,	90

XL.—NOTES ON ANIMAL MECHANICS. By the Rev. SAMUEL HAUGHTON, M.D., Fellow of Trinity College, Dublin.

[Read before the Royal Irish Academy, April 23, 1866.]

No. XIV.—ON THE MUSCLES OF THE VIRGINIAN BEAR.

IN April, 1865, one of the fine Virginian Bears of the Zoological Gardens of Dublin, a female, having fallen into a depressed condition of health, an abscess appeared under the fascia covering the great trochanter of the right thigh, which she persisted in gnawing at to such an extent as to render her an object very unattractive to visitors to the Gardens. She was accordingly sentenced to death by the Council, and the sentence was carried into execution on the 1st of May, 1865, as follows:—

I gave her 12·4 grs. of pure strychnia, in an apple, at 3·17 P. M., and she was dead at 3·52 P. M., having exhibited the following symptoms:—

1. At 20 minutes after dose, her breathing became distressed (108 in the minute);
2. At 24 minutes, she experienced her first tetanic convulsion, the spasm of which never completely relaxed;
3. At 34 minutes, she seemed to be dead;
4. At 35 minutes, she was completely dead, and her heart had ceased to beat.

A.—*Muscles of the Hind Limb.*

	Oz. Av.		Oz. Av.
1. Iliacus, 2. Psoas magnus, }	4·90	8. Obturator internus et gemelli,	1·33
3. Pectinæus,	1·60	9. Glutæus maximus,	4·80
4. Adductor magnus,	14·90	10. Glutæus medius,	6·00
5. Obturator externus,	8·50	11. Pyriformis,	0·95
6. Adductor longus,	2·10	12. Glutæus minimus,	0·45
7. Quadratus femoris,	0·67		

	Oz.Av.		Oz. Av.
13. Biceps femoris, . . .	15·70	18. Sartorius, ...	5·20
14. Semimembranosus, . .	2·70	19. Rectus femoris, . . .	6·40
15. Semitendinosus, . . .	4·40	20. Vastus externus, . .	8·80
16. Gracilis, ...	6·20	21. Vastus internus, . . .	3·40
17. Tensor vaginæ femoris,	2·50	22. Cruræus, ...	0·50

23. Gastrocnemido-solæus, ... 8·10

	Oz.
α. From outer condyle, . . .	4·0
β. From inner condyle, . . .	1·6
γ. From fibula, ...	2·5
	8·10

24. Poplitæus, ... 0·54

Arises by a strong tendon from the outer side of the outer condyle, inside the knee joint, and is inserted into the upper half of the tibia.

25. Flexor digitorum longus,* . . . . 2·30

26. Flexor hallucis longus,* . . . . 0·53

27. Tibialis posticus, ... 0·38

28. Flexori digitorum longo accessorius, ... 0·12

29. Flexor brevis perforatus, ... 0·11

30. Tibialis anticus, ... 1·22

31. Extensor hallucis, ... 0·11

Inserted into the back and outer side of the first phalanx of the hallux.

32. Extensor digitorum longus, ... 1·31

There are also several slips of the *extensor brevis* arising from the surface of the os calcis, in front of the astragalus.

33. Peronæus tertius, ... 0·17

Inserted into the outer side of the first phalanx of the little toe.

34. Peronæus brevis, ... 0·24

Inserted into the outer side of the base of the metatarsal of little toe.

35. Peronæus longus, ... 0·41

Inserted, after crossing the sole of the foot, into the outer side of the base of the metatarsal of the hallux.

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* The *flexor hallucis* tendon is united to the *flexor digitorum longus* tendon in the sole of the foot.

B.—*Muscles of the Fore Limb.*

	Oz. Av.
1. Trapezius clavicularis,	5·90
2. Trapezius scapularis,	9·20
3. Rhomboideus,	—
4. Cleidomastoideus (rope-like muscle),	1·11
5. Omo-atlanticus,	4·40
6. Serratus magnus,	14·10
7. Latissimus dorsi,	12·50
8. Teres major,	2·50
9. Subscapularis,	6·10
10. Pectoralis minor,	1·06
11. Pectoralis major,	15·80
12. Deltoideus clavicularis,	2·80
13. Deltoideus scapularis,	4·50
14. Supraspinatus,	5·60
15. Infraspinatus,	5·10
16. Teres minor,	0·42
17. Infraspinatus secundus,	1·73

May be regarded as belonging either to *subscapularis* or to *infraspinatus*, and is equivalent to *glutæus quintus.*

18. Coracobrachialis,	0·68
19. Coracobrachiali accessorius (like the gemelli),	0·33
20. Triceps humeri, including the fourth or *latissimus dorsi* head, which is 1·70 oz.,	21·70
21. Brachiæus (externus),	3·30
22. Biceps humeri,	4·70
23. Supinator radii longus,	0·89
24. Extensor carpi radialis longior,	0·63

Inserted into the base of the metacarpal of index finger.

25. Extensor carpi radialis brevior,	1·01

Inserted into the base of metacarpal of middle finger.

26. Extensor digitorum communis,	1·06
27. Extensor carpi ulnaris,	1·16

Inserted in the outer side of base of metacarpal of little finger.

28. Extensor minimi digiti (auricularis),	0·61

Distributed to the ungual phalanges of third, fourth, and fifth fingers.

29. Extensor ossis metacarpi pollicis,	1·31

Inserted in the outer side of base of metarcarpal of pollex.

		Oz. Av.
30. Extensor (secundi) internodii pollicis,		0·34
Inserted into the ungual phalanx of pollex.		
31. Supinator radii brevis,		0·81
32. Pronator radii teres,		1·61
33. Flexor carpi radialis,		1·03
34. Palmaris longus,		1·60
35. Flexor carpi ulnaris,		1·42
36. Flexor digitorum sublimis, 37. Flexor digitorum profundus, 38. Flexor pollicis longus,	Terminate in a common tendon, which is distributed to the ungual phalanges of the five fingers; and the upper portion of the common tendon, corresponding to that of the *flexor sublimis*, sends a separate thin slip to the index finger, which slip lies above the index branch of the common tendon.	8·40
39. Pronator quadratus,		0·43
Arises from the lower third of the ulna, and is inserted into the lower fourth of the radius.		

XLI.—Notes on Animal Mechanics. By the Rev. Samuel Haughton, M. D., Fellow of Trinity College, Dublin.

[Read before the Royal Irish Academy, April 23, 1866.]

No. XV.—On the Muscular Anatomy of the Otter (*Lutra vulgaris*).

In March, 1865, I dissected a very fine male Otter, which had lived ten years in the Zoological Gardens of Dublin, and was well known to all the frequenters of those Gardens, from his playful and docile habits. He died of miliary tubercle, accompanied by pneumonic congestion of both lungs; and his right auricle and ventricle, with the two cavæ and hepatic vein, were filled with clotted blood, the result of the pulmonary obstruction.

This beautiful animal was originally presented to the Dublin Gardens by Dr. Horne, of Ballinasloe, on the 8th of March, 1855, and died on the 27th of February, 1865.

The Council of the Zoological Society have made many attempts to rear young Otters, but their exertions have seldom been rewarded with success, owing to the extreme difficulty of procuring suitable food; for the Otter, although aquatic and piscivorous in its habits, is nursed on mother's milk, in a dry warm nest, for a longer period than most carnivorous animals. As the habits of the Otter in this country, in its wild state, are but little known, I make no apology for inserting in this place the following account of the *Lutra vulgaris*, prefatory to my description of his muscles—an account for which I am indebted to Mr. Robert Montgomery, the Secretary of the Royal Zoological Society of Ireland, who has had many opportunities of studying their habits in a state of nature. I can myself bear testimony to the fact, that when cray fish and salmon in the Barrow are scarce, the Otters that frequent its banks will attack and kill young lambs for food:—

"Otter (*Lutra vulgaris*) belongs to the Family of the Mustelidæ. There are at least five well-ascertained species. In early spring the young are produced, generally two, sometimes more; as many as five have been observed. The fur is of two kinds—one thick, short, and soft, brown with white tips; the other coarser in texture, much longer, and darker in colour.

"Pennant mentions one having been killed of 40 lbs., but 24 lbs. is a very large example in this country. It is quite true that they eat the head and shoulders of fish, leaving the remainder, when fish are plentiful; they are trained in Sweden, and still by a few people in England; they are trained very much in the same way as water dogs are. The muscular system of Otters is very largely developed. Its Irish name is *Madia eske*, meaning water dog. *Lutra vulgaris* must not be confounded with the great Sea Otter, *Enhydra marina*, which is a much larger animal, and the skin of which is so much valued by furriers. Pallas says he has known one skin to fetch upwards of £20. In Kamtschatka they are called Kalan; they are still numerous on the west coast of America, as far south as California.

"It is found in Vancouver's Island, which island is rich in Otters, producing three kinds—*Enhydra marina*, the Vison (*Putorius vison*), and our friend, called there the Land Otter, as distinguished from Enhydra. The skin of the latter, even at present, in Vancouver's Island, sometimes reaches six feet in length, and is sent to England to be dressed, and fetches from £12 to £15. The chief market is in China, where they bring 100 dollars (American).

"I have known an Otter to kill waterfowl, and I believe they sometimes kill lambs. Female goes with young nine weeks. Mr. Ogilby, so long Secretary to the London Zoological Society, is of opinion that our Irish Otter is a distinct species from the English; but I do not believe he has ever had an opportunity of verifying this opinion by examining and comparing their skeletons; he judged chiefly from differences in their habits.

"R. M."

A.—*Muscles of the Hind Limb.*

	Oz. Av.
1. Sartorius,	0·30
2. Psoadiliacus,	0·25
3. Pectinæus,	0·07
4. Adductor brevis,	0·10
5. Adductor magnus,	0·43
6. Obturator externus,	0·07
7. Adductor longus,	0·50
8. Quadratus femoris,	0·03
9. Obturator internus et gem.	0·04
10. Agitator caudæ,	0·06
11. Glutæus maximus et Tensor vaginæ femoris,	0·82
12. Glutæus medius et Pyriformis,	0·40
13. Glutæus minimus,	0·08
14. Biceps femoris,	0·51
15. Bicipiti accessorius,	0·05
16. Semimembranosus,	0·49
17. Semitendinosus,	0·24
18. Gracilis,	0·23
19. Quadriceps extensor femoris,	1·11
20. Gastrocnemius,	0·61
21. Plantaris,	0·25
22. Solæus,	0·01
23. Poplitæus,	0·06
24. Flexor digitorum longus,	0·05

Inserted into the common junction of the tendons of *flexor hallucis longus* and *accessorius*. The tendons of this muscle are distributed chiefly to the hallux and index.

	Oz. Av.
25. Flexor hallucis longus,	0·22

This acts in the Otter as a common flexor, and is analogous to the *flexor profundus* of the hand.

26. Tibialis posticus,	0·06
27. Flexor digitorum brevis,	0·02
28. Flexori longo accessorius,	0·01
29. Tibialis anticus,	0·32
30. Extensor digitorum longus,	0·14
31. Extensor minimi digiti,	0·03

Its tendon passes under the groove of the outer ankle, with that of the *peronæus brevis,* and is inserted into the outer side of the ungual phalanx of the little toe.

32. Peronæus tertius,	0·02
33. Peronæus brevis,	0·06
34. Peronæus longus,	0·05

B.—*Muscles of Fore Limb.*

1. Trapezius scapularis,	0·47
2. Trapezius clavicularis,	0·64
3. Sternomastoideus,	0·72

Inserted into the first rib, the top of sternum, and raphe of lower part of neck.

4. Cleidomastoideus,	0·17
5. Omo-atlanticus, No. (1),	0·27

Arises from the anterior surface of the transverse process of the atlas, and is inserted into the anterior third of the spine of the scapula.

6. Omo-atlanticus, No. (2),	0·21

Arises from the anterior surface of the transverse process of the atlas, and is inserted into the posterior third of the spine of the scapula.

7. Serratus magnus,	1·11

In this muscle I have included the *levator anguli scapulæ,* which is quite distinct from *omo-atlanticus* No. 2, and takes its origin from the middle of the occipital line, and is inserted into the vertebral edge of the scapula, immediately above the end of its spine. The remainder of the *serratus magnus* takes its origin from the costal processes of the cervical vertebræ (2 — 7), and from the first seven ribs.*

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* There are fourteen ribs in all.

	Oz. Av.
8. Rhomboideus,	0·35

Arises from the occipital ridge, from all the cervical vertebræ, and from the first two dorsal.

9. Teres major,	0·14
10. Latissimus dorsi,	1·14

Has a double insertion.

a. Connected with the *cutaneous accessory* into the tendon of the *pectoralis minor*, near its insertion, and at its lower border, strapping down the *biceps* upon the bone. Takes origin from the posterior surfaces of the last five ribs.

b. By a tendon common to it and *teres major*, into the humerus, under *biceps*, as usual. Takes origin from the posterior surfaces of the seventh, eighth, and ninth ribs.

11. Subscapularis,	0·65
12. Pectoralis minor,	1·12

Takes origin at sternum from the ribs (4 — 9), and is inserted, strapping down the *biceps* into three-fourths of the length of the humerus.

13. Pectoralis major,	0·72

Takes origin at sternum, from the first four ribs, and is inserted into the outer side of the pectoral ridge of the humerus, and by fascia into the skin of the forearm.

14. Deltoideus clavicularis,	0·10

Inserted into the inner side of the pectoral ridge of the humerus and into the ulna, with the tendon of *brachiæus*.

15. Deltoideus scapularis,	0·12
16. Supraspinatus,	0·45
17. Infraspinatus,	0·21
18. Biceps humeri,	0·16
19. Brachiæus (externus),	0·14
20. Triceps (including fourth head from tendon of *latissimus dorsi*),	1·40
21. Anconæus,	0·05
22. Pronator radii teres,	0·08
23. Flexor carpi radialis,	0·04
24. Palmaris longus,	0·12
25. Flexor carpi ulnaris,	0·10
26. Flexor digitorum sublimis,	0·19
27. Flexor digitorum profundus,	0·15
28. Flexor pollicis longus,	
29. Pronator quadratus,	0·02
30. Supinator radii longus,	0·19

	Oz. Av.
31. Extensor carpi radialis, ...	0·23

Inserted by a bifurcate tendon into the near ends of the metacarpals of index and middle fingers.

32. Supinator radii brevis, ...	0·02
33. Extensor digitorum communis, ...	0·05
34. Auricularis, ...	0·04

Inserted into the little, ring, and middle fingers.

35. Extensor carpi ulnaris, ...	0·07

Inserted into the near end of the metacarpal of the little finger.

36. Extensor ossis metacarpi pollicis, ...	0·05
37. Indicator, ...	0·01

Inserted by a double tendon into the index and middle fingers.

XLII.—Notes on Animal Mechanics. By the Rev. Samuel Haughton, M. D., Fellow of Trinity College, Dublin.

[Read before the Royal Irish Academy, April 23, 1866.]

XVI.—On the Muscular Anatomy of the Rhinoceros.

A young male Rhinoceros, three years old, having died in the Zoological Gardens of Dublin in April, 1865, the body was purchased, for £17, for the Museum of Trinity College, and I availed myself of the opportunity of making a careful examination of his muscles. I was ably assisted in the dissection by Mr. Macalister, Demonstrator in Anatomy of the Royal College of Surgeons, and by a staff of medical students, who relieved each other from time to time. The stench from the decomposing blood was almost intolerable, and several of my assistants were disabled by typhoid diarrhœa; this I escaped myself, as I had done on a former occasion when dissecting a Nylghau, which had died of putrid fever, and whose blood after death seemed to communicate diarrhœa by its smell to almost every person in contact with the body. Notwithstanding these difficulties, I was able to complete the entire muscular dissection in person, the results of which cannot fail to prove of interest to anatomists.

Having made a careful *post-mortem* examination of all the viscera, except the brain, I felt it my duty to lay the following Report before the Council of the Zoological Society:—

"School of Physic, Trinity College,
"*Dublin, April* 14, 1865.

"Report on Death of the Rhinoceros.

"The Rhinoceros died at 4 a. m. on Thursday, the 6th inst., and his body was opened in the new Dissecting Room of Trinity College on the 8th inst., at 1 p. m.

"I was assisted in making the *post-mortem* examination by Professor Ferguson and Mr. Connor; there were also present Dr. Alexander Carte, Dr. M'Dowel, Dr. Bennett, Dr. Macalister, and several other anatomists.

"The rectum was protruded through a space of eighteen inches, and in it were two *post-mortem* ruptures; in the ilium, two feet from the cæcum, there was extensive softening, as also at the junction of the duodenum and jejunum; the stomach was filled to distention with a mixture of hay and whole Indian corn, both fermenting, and pervaded with an aldehydic smell, which overcame even the intolerable odour of the gases with which the abdomen was distended almost to the bursting point; the hay was somewhat masticated, but the corn had been bolted whole; numerous tapeworms were found in the upper part of the intestines.

"The decomposition set in with most unusual rapidity, particularly in the anterior extremity, and it was with the greatest difficulty that a few precious fragments of the viscera of this rare animal could be preserved; many of the muscles also dissolved in the course of twenty hours into a mass of putrid jelly. This phenomenon was most marked in the left side of the thorax and left anterior limb.

"CAUSE OF DEATH.

"I believe that death was caused by the improper administration of Indian corn, which fermented in the stomach and intestines, and developed gas to such an extent as to cause prolapsus of the rectum, and that the pressure caused by this gas ultimately destroyed the action of the diaphragm, and so caused death by asphyxia; and I am further of opinion that it is the duty of the Council to institute the most searching inquiry into the manner in which Indian corn was given to this animal, as such food does not appear in the scale of dietary formally prescribed by the Council's order to be used.

(Signed) "SAMUEL HAUGHTON, *Hon. Sec. R. Z. S.*

"P. S.—The tapeworms were in all probability the cause of the convulsions experienced by the Rhinoceros shortly after his arrival in the Dublin Gardens. "S. H."

A.—*Muscles of the Hind Limb.*

	Oz. Av.
1. *Sartorius*, ...	12·5

Origin; from the inner margin of the narrowest part of the ilium, near the insertion of the *psoas parvus.*

Insertion; by flat tendinous fascia into the inner side of the leg below the knee.

2. *Psoas magnus*, ...	47·5

Origin; from the lumbar vertebræ, with one slip from the true pelvis, from the inner margin of the ilium.

Insertion; by a common tendon with, and inside the *M. iliacus*, into the lesser trochanter.

3. *Iliacus*, ... 34·5

Origin and insertion; as usual.

4. *Pectinæus*, ... 28·0

Origin; from the inferior margin of the anterior crest of the pubis.

Insertion; into the femur at lower point of trisection, by a strong round tendon.

5. *Adductor brevis*, ... 7·0

Origin; from the symphysis pubis (middle two inches).

Insertion; by a flat tendon, inside the insertion of the *adductor magnus*.

6. *Adductor magnus*, ... 32·5

Origin; from the arch of the pubis, backwards, nearly as far as the tuberosity of the ischium.

Insertion; into the back of the outer condyle, and halfway up the femur.

7. *Obturator externus*, ... 19·0

Origin; as usual.

Insertion; into the upper half of the line leading from the great trochanter to the posterior trochanter.

8. *Adductor longus*, ... 12·0

Origin; from the arch and symphysis of the pubis, lying under the *M. gracilis*.

Insertion; into the lower half of the *linea aspera* and inner condyle of the femur.

9. *Quadratus femoris*, ... wanting.

10. *Obturator internus*, ... 3·0

Origin; from the ilium above the ischiadic notch, and without any fibres from the rim of the foramen; it is a long slip of muscle (Qu. *Gemellus superior ?*)

11. *Gemellus inferior*, ... 2·5

12. *Glutæus maximus* (Fig. 36), ... 208·0

Origin; from the posterior half of the ilio-ischiadic line, and from the sacro-ischiadic ligament.

Insertion; by means of a tendon, 4½ inches in length, into the top of the fibula and fascia of the leg; it gives off two tendinous slips to the greater and posterior trochanters in passing.

13. *Glutæo maximo accessorius* (Fig. 36), ... 13·0

Origin; from the vertebral edge of the ilio-ischium, in front of the origin of the *Glutæus maximus*.

Insertion; by a long tendon into the posterior trochanter.

Oz. Av.

14. *Glutæus medius* (Fig. 36), ... 98·5

Origin; from the whole outer surface of the ilium, being overlapped on its posterior border by *gl. max.*, and its accessory, No. 13.

Insertion as usual.

15. *Glutæus minimus*, ... 13·0

Origin; from a small surface of the narrowest portion of the ilium, near the ischiadic notch.

Insertion; into the anterior ridge of the great trochanter.

16. *Tensor vaginæ femoris*, ... 67·5

Origin; from the crest of the ilium.

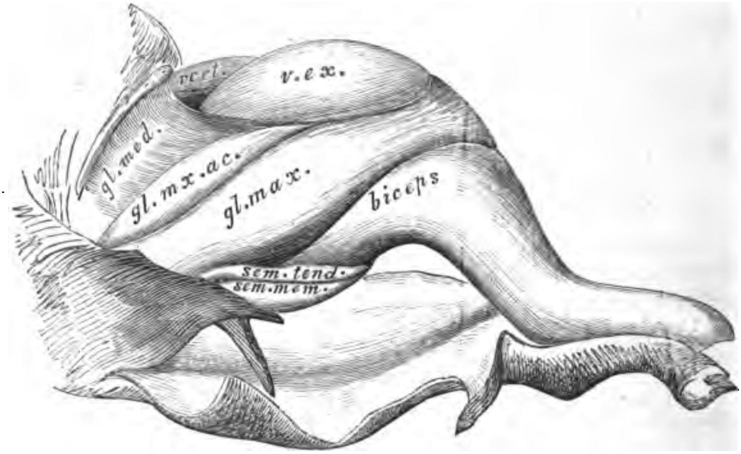
Insertion; into the fascia of the knee, principally on the outer side, but partly on the inner side; its insertion on the outer side is separated from the *glutæus maximus* by a strong fascia.

17. *Biceps femoris* (Fig. 36), ... 48·0

Origin; from the tuberosity of the ischium.

Insertion; into the whole length of the outer side of the leg, as far down as the heel, by fascial attachment; and is intimately blended in its muscular portion with the *semitendinosus*.

Fig. 36.



18. *Semimembranosus* (Fig. 36), ... 66·0

Origin; from the tuberosity of the ischium, with posterior fibres from the great ischiadic ligament.

Insertion; into the back and inner side of the inner condyle, with a prolongation to the tibia by fascial attachment.

Oz. Av.

19. *Semitendinosus* (Fig. 36), ... 64·0

Origin; from the tuberosity of the ischium.

Insertion; by a tendon, one inch broad, into the point of bisection of the tibia.

20. *Gracilis*, ... 45·0

Origin; from the arch of the pubis and two inches of posterior portion of its symphysis.

Insertion; into the head of the tibia, by a tendon, three inches in length.

21. *Rectus femoris* (Fig. 36), ... 54·0

22. *Vastus externus* (Fig. 36), ... 54·5

A strong ligament joins the greater and posterior trochanters, under which the outer head of the *vastus externus* passes.

23. *Vastus internus*, ... 41·5

24. *Cruræus*, ... 21·5

25. *Poplitæus*, ... 5·5

Origin; by a strong tendon from the outer condyle of the femur; this tendon forms one of the ligaments of the knee joint, and winds round the back of the head of the fibula.

Insertion; into the upper half of the back of the tibia.

26. *Gastrocnemido-solæus*, ... 29·0

Insertion; into the os calcis.

27. *Plantaris* (*flexor perforatus*), ... 3·5

Origin; from the back of the outer condyle, covered by *gastrocnemius*.

Insertion; into the *plantar fascia* covering the os calcis, from which it passes on to the common junction of flexor tendons in the sole of the foot, and ultimately expends its force on the three *perforate* tendons of the toes.

N. B.—This seems to be the *plantaris* and *flexor digitorum brevis* (*perforatus*) combined.

28. *Flexor digitorum* (*perforans*), ... 21·0

Origin; from the whole back of the fibula, and from the lower half of the tibia.

N. B.—This seems to be the *flexor digitorum longus* and *flexor hallucis longus* combined.

29. *Tibialis anticus*, ... 10·0

Origin; from the upper anterior half of the tibia.

Insertion; into the inner edge of the inner tarsal (*cuneiform*).

Oz. Av.

30. *Extensor digitorum longus*, ... 19·5

Origin; from the outer condyle of the femur, by a strong tendon.
Insertion; double:—

	Oz. Av.
a. Into the inner tarsal (cuneiform), . . .	5·5
b. By two tendons inserted into the inner sides of the first phalanges of outer and inner toes, ...	14·0
	19·5

31. *Peronæus longus*, ... 1·75

Origin; from the outer condyle of the femur.
Insertion; by a pulley passing under the outer ankle, winding obliquely outside it, and crossing the sole of the foot, to be inserted two-thirds of the way across into the under surface of the middle cuneiform bone.

32. *Peronæus brevis*, ... 3·5

Origin; from the whole outer side of the fibula.
Insertion; into the near end of the first phalanx of the outer toe.

33. *Extensor brevis digiti medii*, ... 9·5

Origin; by a strong tendon from the calcaneum, just below the ankle joint, and by fascia from the whole breadth of the instep.
Insertion; into the near end of the first phalanx of the middle toe.

34. *Interossei digiti externi*, ... 5·0
35. *Interossei digiti medii*, ... 2·0
36. *Interossei digiti interni*, ... 4·0

B.—*Muscles of the Fore Limb.*

Oz. Av.

1. *Trapezius clavicularis* (vel *cervicohumeralis*), ... 35·0

Origin; from the transverse process of the axis.
Insertion; into the head of the humerus, in a transverse line, 2½ inches long, from the great tuberosity.

2. *Trapezius scapularis*, ... 32·0

Origin; from the spines of the dorsal vertebræ.
Insertion; into the end of the spine of the scapula.

3. *Omo-atlanticus* (vel *brachio-atlanticus*), ... 24·0

Origin; from the transverse process of the atlas.
Insertion; into the front of the lower part of the humerus: is a long round muscle.

Oz. Av.

4. *Rhomboideus*, ... 8·5

Oz. Av.

a. Externus, vel levator anguli inferioris scapulæ, 7·0
b. Internus, ... 1·5

8·5

5. *Serratus magnus*, ... 79·0

Includes the *levator anguli scapulæ superioris.*

6. *Teres major*, ... 21·0

7. *Latissimus dorsi*, ... 61·0

Has tendon in common with *teres major.*

8. *Tricipiti accessorius*, ... 22·0

This muscle takes its origin from the ribs, and forms a costal head of the *triceps*, into the back of which it passes, behind the olecranon process.

9. *Subscapularis*, ... 28·0

10. *Pectoralis minor?* . . . . 98·0

Origin; from the sternum and first six ribs.

Insertion; into the pectoral ridge, from the greater to the lesser tuberosity of the humerus.

11. *Pectoralis major?* . . . . 49·5

Origin; from the keel along the anterior half of the sternum, and from the ribs.

Insertion; into the oblique line down the whole inner side of the ulna.

12. *Pectoralis avium?* (*subclavius?*) . . . . 24·0

Origin; from the first rib and side of the top of sternum.

Insertion; into the outer summit of the greater tuberosity, and by fascia passing over the *supraspinatus*, into the scapulæ—*levator humeri.*

13. *Coraco-brachialis*, ... 2·5

Origin; from the coracoid process inside the *biceps.*

Insertion; into the inner and anterior side of the middle of the humerus, by a flat insertion, three inches in length.

14. *Deltoideus scapularis*, ... 25·5

Origin; from nearly the whole length of the spine of the scapula.

Insertion; into the outer side of the great tuberosity.

N. B.—The *deltoideus clavicularis* is merged in the *cervico humeralis*, or *trapezius clavicularis* No. (2), which forms a part of the great *delto-trapezius.*

Oz. Av.

15. *Supraspinatus*, ... 83·0

16. *Infraspinatus*, ... 55·0

17. *Biceps humeri*, ... 21·5

This muscle takes origin as usual; but it is remarkable that the tendon passing over the head of the humerus is much stronger than the muscle itself requires. I do not know the reason of this singular circumstance.

Inserted, as usual, into the tubercle of the radius.

18. *Brachiæus externus*, ... 34·5

Origin; arises from the outside, backside, and part of the inside of the head of the humerus, winding outwards round the shaft of the bone, to be inserted in the radius by a flat prolonged tendon, below and to the inside of the tubercle of the radius.

19. *Triceps humeri*, ... 224·0

20. *Flexor carpi radialis?* . . . . 8·75

Origin; from the inner side of the inner condyle of the humerus.

Insertion; by a long tendon passing in a groove at the inner side of the wrist, then plunging deep into the palm, to be finally inserted, below the short flexors, into the bases of the metacarpals of the inner and middle fingers.

21. *Palmaris longus*, ... 6·25

Origin; from the inner and back side of the olecranon.

Insertion; into the common junction of the palmar tendons at the bend of the wrist.

22. *Flexor carpi ulnaris*, ... 4·5

Origin; from the back of the inner condyle and olecranon.

Insertion; into the carpal bone (*pisiforme*), articulating with the ulna.

N. B.—A ligament connects this bone with the sesamoid bone, into which the *extensor carpi ulnaris* is inserted, so as to cause both muscles to *flex* and *abduct* the outer side of the hand.

23. *Flexor digitorum communis*, ... 19·5

The superficial and deep flexors unite in a common tendon at the wrist, from which proceed three perforating and three perforate flexors. At the same point of junction of tendons there are also found—

1. A tendinous ligament from the inner condyle, without any muscular fibres attached;
2. The tendon of a small muscle (24), which seems to be the *flexor pollicis longus*.

24. *Flexor pollicis longus?* . . . . 1·0

Origin; from the radius and ulna, and interosseous septum.

Oz Av.

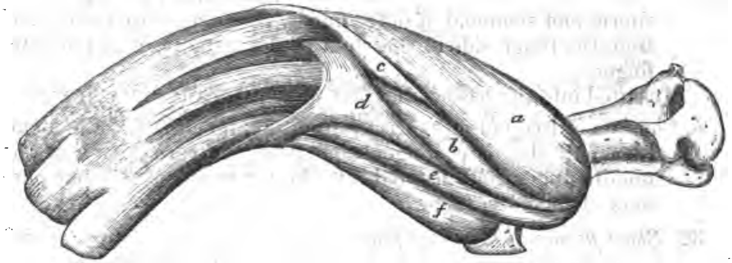
25. *Supinator radii longus?* . . . . 1·75

Origin; from the fascial covering of the outer condyle.
Insertion; into the tendon of (26) at the wrist.

N. B.—This muscle acts chiefly as a tensor fasciæ, but is, no doubt, the representative of the *sup. rad. longus.*

26. *Extensor carpi radialis* (Fig. 37, *a*), ... 37·5

Fig 37.



Left Fore Arm.

Origin; from the outer condyle.
Insertion; into the near end of the metacarpal of the middle finger.

N. B.—This muscle receives at the bend of the wrist the tendon of the *supinator longus.*

27. *Extensor digitorum longus* (Fig. 37, *b*), ... 13·5

Inserted into the near end of the first phalanx of the middle finger.

28. *Extensor minimi digiti* (Fig. 37, *e*), ... 6·0

Origin; from the outer condyle, and from the tendinous expansion of the interosseous septum from the outer condyle to the wrist.
Insertion; into the outer side of the first phalanx of the outer finger, with a tendinous slip to the metacarpal of the middle finger.

29. *Extensor carpi ulnaris?* . . . . 27·5

Origin; from the outer condyle.
Insertion; into the sesamoid bone outside the base of the metacarpal of the outer finger.

N. B.—I am almost certain that this muscle is the *extensor ulnaris,* although, owing to the arrangement described in (22), it acts as a *flexor.* The combined actions of the ulnar flexor and extensor would be to abduct the little finger—an action which would be of great use to the Rhinoceros when running on soft ground.

30. *Extensor ossis metacarpi pollicis* (Fig. 37, *c*), ... 4·5

Origin; from the anterior half of the radius and ulna, and from the interosseous septum.
Insertion; its tendon crosses the back of the wrist, binding down the tendons of the radial extensor, and is inserted into the outer side of the near end of the metacarpal of the inner finger.

Oz. Av.

The following muscles are found in the palm:—

31. *Short flexors of the outer finger,* . . . . 5·5

	Oz. Av.
a, ...	2·5
b, ...	3·0
	5·5

a. Origin; from the ligament already described (22) joining the pisiform and sesamoid of outer finger, from one carpal bone, and from the inner side of the shaft of the metacarpal of the outer finger.

Inserted into the base of the first phalanx of the outer finger.

b. Consists of two muscles, arising from the inner half of the metacarpal of the outer finger, and from the carpal bone of the middle finger, and inserted into the inner side of the first phalanx of the outer finger.

32. *Short flexors of the inner finger,* . . . . 5·0

These are two in number, and similar to those of the outer finger.

33. *Short flexors of the middle finger,* . . . . 2·0

These are two in number.

XLIII.—NOTES ON ANIMAL MECHANICS. By the Rev. SAMUEL HAUGHTON, M. D., Fellow of Trinity College, Dublin.

[Read before the Royal Irish Academy, April 23, 1866.]

XVII.—ON THE COMPARATIVE MYOLOGY OF CERTAIN BIRDS.

IN order to compare the muscles of different classes of birds, I dissected two Tiercel Peregrines, a Falcon Peregrine, a Cara Cara Hawk, a Demoiselle Crane, and a Canadian Goose.

The Cara Cara Hawk (*Polybarus*, or *Falco Braziliensis*) presents a most striking resemblance to the Peregrine Hawk, and, judging from his muscular anatomy, must be regarded as a Hawk, and not a Vulture.

A.—*Muscles of the Leg.*

	TIERCEL.	FALCON.	CARA.	CRANE.	GOOSE.
	Oz.	Oz.	Oz.	Oz.	Oz.
1. *Sartorius*,[a] . . .	0·05	0·08	0·05	0·11	0·57
2. *Adductores*,[b] . .	0·04	0·05	0·09	0·18	0·40

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[a] The *Sartorius* takes its origin from the anterior curved edge of the ilium, and is inserted by a broad tendon into the side of the knee joint and tibia.

[b] In the Peregrine and Cara there was only one *adductor*; in the Crane and Goose there were two, viz.—

	CRANE.	GOOSE.
	Oz.	Oz.
Adductor magnus, . .	0·12	0·23
Adductor longus, . . .	0·06	0·17
	0·18	0·40

	TIERCEL. Oz.	FALCON. Oz.	CARA. Oz.	CRANE. Oz.	GOOSE. Oz.
3. *Obturator externus*,	0·03	0·03	0·04	0·04	0·12
4. *Obtur. internus*, &c.,	0·02	0·02	0·03	0·02	—
5. *Gubernator caudæ*,[c]	0·02	0·02	0·02	—	0·20
6. *Glutæus maximus*,[d]	0·01	0·01	0·01	0·09	1·07
7. *Glutæus medius*,[e]	0·04	0·04	0·10	0·17	0·78
8. *Glutæus minimus et Gl. quartus*,[f]	0·04	0·03	0·03	0·04	0·73
9. *Tensor vaginæ femoris*,[g]	0·07	0·03	0·07	—	0·52
10. *Biceps femoris*,[h]	0·08	0·08	0·10	0·16	0·72
11. *Semimembranosus*,[i]	0·02	0·02	0·05	0·09	0·17
12. *Semitendinosus*,[i]	0·03	0·03	0·05	0·07	0·07
13. *Gracilis*,[k]	0·04	0·03	0·05	—	0·11
14. *Rectus femoris*,[l]	—	—	—	—	—
15. *Vastus externus et Vastus internus*,	0·13	0·11	0·13 0·03	0·30	0·85

		CRANE. Oz.	CARA. Oz.
16. *Gastrocnemido-solæus*,		0·31	0·18
a. Outer head,	0·09		(Four heads).
β. Middle head,	0·06		
γ. Inner head,	0·16		
	0·31		
17. *Plantaris*,		0·01	—
18. *Tibialis anticus*,		—	0·14

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[c] This muscle is quite distinct from the *agitator caudæ*, and lies in a plane below it. In the Falcon and Cara it takes origin from the transverse process of the large terminal caudal vertebra (*ploughshare*), and is inserted into the second fifth from the top of the linea aspera by means of a flat tendon; in the Goose it is inserted into the middle of the lower part of the *glutæus medius*; and in the Duck into the outer head of the fibula.

[d] The *glutæus maximus* in the Falcon and Cara takes its origin from the edge of the ilium, in a plane below that of the *ten. vag. fem.*, for one-fourth of an inch in front of the acetabulum, and has the usual insertion; in the Crane its origin is from the post-acetabular edge of the ilium, and it is inserted by a broad tendon into the middle of the *vastus externus* and fascia of the outer side of the thigh; and in the Goose it is inserted into the fascia of the inner side of the knee.

[e] The *gl. medius* has the usual insertion in the Falcon, Cara, and Crane; but in the Goose and Duck it is inserted into the middle of the *linea aspera*.

[f] Quite separate in the Crane; *gl. min.* = 0·01, *gl. quartus* = 0·03.

[g] This small muscle, in conjunction with the *sartorius*, in most birds serves instead of a *rectus femoris*.

[h] The *biceps femoris* in the Falcon, Cara, and Crane, passes through the usual tendinous pulley at the outer side of the lower end of the femur, and outer head of the *gastrocnemius*; in the Goose and Duck it is inserted into the tibia, at the inner side of the knee.

[i] These muscles in the Falcon and Cara are inserted by flat tendons into the tibia; and in the Crane they are also inserted into the upper tendinous portion of the inner head of the *gastrocnemius*.

[k] This muscle, in the Falcon and Cara, takes origin from three-fourths of the length of the pubis, behind the acetabular prominence of that bone.

[l] There is a *rectus femoris* in the Falcon and Cara, arising from the ilium, in front of the acetabular prominence of the pubis; it is a fine delicate muscle, weighing 0·01 oz. in the Cara, and its tendon passes obliquely across the front of the knee joint from within outwards, and, winding down into the calf, forms one head of the *first perforate flexor of the second toe*, the muscular portion of which is connected by muscular slips with the *first perforate flexors* of the third and fourth toes, and with the *second perforate flexor* of the third toe. The weight of the *first perforate flexor* of the second or index toe in the Cara, was 0·02.

This muscle is thus described by Cuvier:—

"Il y a dans le lieu qu'occupe le pectineux des quadrupedes, un petit muscle grêle, qui se prolonge jusqu'au genou. Son tendon passe obliquement pardessus, et se glisse derriere la jambe pour s'unir au fléchisseur perforé du second et du cinquième doigt."*

Professor Owen† regards this muscle as the *gracilis*; while he considers as *rectus femoris* the muscle already described as *tensor vaginæ femoris*.

* "Lecons d'Anatomie comparée," tom. i., p. 359.
† "Cyclopædia of Anatomy," vol. i., p. 296.

B.—*Muscles of the Wing.*

	TIERCEL. Oz.	FALCON. Oz.	CARA. Oz.	CRANE. Oz.
1. *Serratus magnus*,	0·04	0·06	0·05	—
2. *Rhomboideus*,	0·02	0·03	0·07	—
3. *Teres major*,[m]	0·02	0·02	0·02	—
4. *Latissimus dorsi*,	0·03	0·03	0·04	—
5. *Subscapularis*,	0·04	0·04	0·04	—
6. *Pectoralis minor*,	0·05	0·05	0·04	0·06
7. *Pectoralis major*,[n]	0·73	0·76	1·03	2·00
8. *Pectoralis secundus avium*,	0·08	0·11	0·10	0·37
9. Wingfolder (*extensor plicæ alaris*),[o]	0·03	0·04	0·04	—
10. *Coracobrachialis*,	0·03	0·03	0·02	—
11. *Deltoideus internus* (*clavicularis*),[p]	0·03	0·02	0·02	—
12. *Deltoideus externus* (*scapularis*),[q]	0·09	0·08	0·12	—
13. *Supra et infra spinatus*,[r]	0·09	0·07	0·10	—
14. *Biceps humeri*,	0·05	0·04	0·06	—
15. *Triceps humeri*,	0·11	0·14	0·15	—

XLIV.—NOTES ON ANIMAL MECHANICS. By the Rev. SAMUEL HAUGHTON, M. D., Fellow of Trinity College, Dublin.

[Read before the Royal Irish Academy, April 23, 1866.]

XVIII.—ON THE COMPARATIVE MYOLOGY OF CERTAIN RUMINANTS.

IN the following comparisons of the muscles of Ruminants I have made the Indian Goat the standard; the other animals examined being the Virginian Deer, the Nylghau, and Napu Deer of Java.

A.—*Muscles of the Hind Limb.*

	GOAT. Oz.	DEER. Oz.	NAPU. Oz.
1. *Sartorius*,[s]	0·11	1·25	0·13
2. *Tensor vag. femoris*,	0·42	4·25	
3. *Psoas magnus*,	0·97	7·50	0·37
4. *Iliacus*,	0·26	2·50	0·05
[*Psoas parvus*],	0·15	1·75	0·04
5. *Pectinæus*,	—	2·25	0·03

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[m] The *teres major* arises from the spinous processes of the lower dorsal vertebræ, and crosses the lower extremity of the scapula, to be inserted by a flat tendon into its usual place in the humerus.

[n] A slip from the upper edge of this muscle joins the wingfolder (*extensor plicæ alaris* Carus).

[o] This muscle takes its origin from the acromion, and is inserted into the wrist, acting directly as a folder of the wing.

[p] Arises from the tip of the acromion, and is inserted into the top of the humerus, inside the pectoral ridge.

[q] Origin, from the portion of the scapula adjoining the acromion; insertion into the outer side of the pectoral ridge of the humerus; rotates the arm powerfully outwards.

[r] Arise from the lower two-thirds of the outer side of the scapula.

[s] The *sartorius* in the Goat has a double origin—

a. From the anterior edge of the pubis, close to the acetabulum.
b. From the anterior superior crest of the ilium, by fascia.

	Goat. Oz.	Deer. Oz.	Napu. Oz.
6. *Adductor brevis*,	0·41	—	0·05
7. *Adductor longus*,	1·28	—	—
8. *Adductor magnus*, 9. *Semimembranosus*, } [b]	1·19	28·50	0·66
10. *Semitendinosus*,	0·43	9·25	0·13
11. *Obturator externus*,	0·48	—	—
12. *Quadratus femoris*,	0·12	—	0·03
13. *Obturator internus*, &c.,[c]	0·17	—	—
14. *Glutæus maximus*, 15. *Biceps femoris*, } [d]	1·86	36·5	0·59
16. *Glutæus medius*,	1·11	10·0	0·19
17. *Glutæus minimus*,[e]	0·50	1·75	0·06
18. *Glutæus quartus (iliocap.)*,[e]	0·29	1·00	0·04
19. *Gracilis*,[f]	0·40	4·50	0·08
20. *Rectus femoris*,	1·15	10·50	—
21. *Vastus externus* (a),	0·85	11·75	—
22. *Vastus externus* (b),	0·28	—	—
23. *Vastus internus* (a),	0·36	4·25	—
24. *Vastus internus* (b),	0·29	—	—
25. *Cruræus*, &c.,	—	2·75	—

Leg of Goat.

	Oz.		Oz.
26. *Gastrocnemido-solæus*,	0·92	31. *Tibialis anticus*,[i]	0·22
27. *Plantaris*,[g]	0·06	32. *Extensor digitorum communis*,[i]	0·09
28. *Poplitæus*,	0·15	33. *Peronæus longus*,	0·04
29. *Flexor digitorum longus*,	0·25	34. *Peronæus brevis*,	0·08
30. *Flexor hallucis longus*,[h]	0·04		

B.—*Muscles of the Fore Limb in the Goat.*

	Oz. Av.
1. *Trapezius scapularis*,	0·35

Origin; from the cervical vertebræ (4 – 7); and from the dorsal (1 – 4).

Insertion; into the spine of the scapula; separable with difficulty from the next.

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[b] These muscles are combined in their muscular portion into one fleshy mass in the Goat, Deer, Nylghau, and little Napu; but retain their characteristic insertions into the whole length of the back of the femur, and into the top of the tibia and fascia of knee joint.

[c] The anterior border of the *gemelli* joins the posterior border of the *iliocapsularis*.

[d] The *gl. max.* and *biceps fem.* form one muscle, having the double origin. In the Goat the insertion is into the fascia of the thigh below the trochanter, and one-third down the outer side of the leg; in the Deer and Nylghau the portion with glutæal origin has bicipital insertion, and the portion with bicipital origin is inserted into the fascia of the inner side of the knee; in the Napu the origin of these muscles is covered by the sacral fascia, which, with the lumbar, is converted partially into a bony covering; the insertion is into the fascia of the knee joint, and down the whole outer side of the leg as far as the os calcis.

[e] The *gl. min.* and *gl. quartus* form one muscle in the Nylghau.

[f] Inserted with the *semitendinosus* into the upper third of the leg.

[g] The *plantaris* is represented by a muscular slip from the back of the top of fibula.

[h] This little muscle takes its origin from the tibia, just below the *poplitæus*, and is inserted at half an inch below the heel into the tendon of the common flexor.

[i] The *tibialis anticus* arises from the anterior curved surface of the tibia, and by a round tendon, common to it with the *extensor digitorum longus*, from the anterior surface of the outer condyle, inside the knee joint.

Oz. Av.

2. *Trapezius* (*clavicularis*), (*Humeromastoideus*), ... 0·77

Origin; from the mastoid process and fascia covering the second vertebra.

Insertion; into the fascia of No. 1, covering the anterior portion of the spine of the scapula, passing downwards (as external deltoid) into the fascia covering the *biceps*, and finally inserted by common tendon with biceps into the forearm.

3. *Rhomboideus*, ... 0·31

Including an accessory slip from the fourth cervical.

4. *Serratus magnus*, ... 2·73

5. *Teres major*, ... 0·23

6. *Latissimus dorsi*, ... 0·43

There is also a *latissimus dorsi superficialis*, part of the *panniculus carnosus*, which extends from the border of the true *lat. dorsi et pectoralis major*, partly covering both these muscles, and is inserted into the fascia of the back of the humerus, both on the inner and on the outer side, and into the elbow joint.

7. *Subscapularis*, ... 0·59

8. *Pectoralis minor*, ... 0·82

9. *Pectoralis major*, ... 0·51

Inserted into the fascia binding down the *biceps*, and into the near end of the ulna.

10. *Coracobrachialis*, ... 0·07

11. *Deltoideus externus*, ... 0·13

Lies under the *humeromastoid*.

12. *Supraspinatus*, ... 1·72

13. *Infraspinatus*, ... 1·34

14. *Teres minor*, ... 0·09

Arises from the middle of the lower border of the scapula, and is inserted into the fascia covering the outer head of the *triceps*.

15. *Infraspinatus secundus*, ... 0·12

This muscle is analogous to the *glutæus quintus* of the hind limb, found in the Kangaroo.

Origin; from the anterior third of the lower border of the scapula.

Insertion; into the greater tuberosity of the humerus, below the tendon of the *infraspinatus*, to which it seems related, as the *iliocapsularis* (*gl. quartus*) is to the *gl. minimus*.

Oz. Av.

16. *Biceps humeri*, ... 0·32

Inserted partly into the front of the bone of the forearm, to which it gives a direct lift, and partly by a tendon winding in a groove round it, being inserted into its inner and under surface.

17. *Brachiæus* (*externus*), ... 0·26

Its tendon crosses the tendon of *biceps*, and is inserted on the inner and under side of the bone of the forearm, below the insertion of the *biceps*.

18. *Triceps*, ... 1·98

Has a fourth head, from *latissimus dorsi*.

19. *Anconæus*, ... 0·16

20. *Flexor carpi ulnaris*, ... 0·11

Inserted into the near end of cannon bone by a common tendon with *extensor carpi ulnaris*.

21. *Flexor carpi radialis*, ... 0·07

Origin; from the inner condyle.

Inserted into the near and inner end of the cannon bone by a tendon passing through a groove in the wrist, inside that of the *flexor profundus*.

22. *Flexor digitorum sublimis*, ... 0·22

23. *Flexor digitorum profundus*, ... 0·48

24. *Supinator radii longus*, ... 0·32

Inserted into the back of near end of cannon bone.

25. *Extensor carpi radialis*, ... 0·05

Distributed to the back of ungual phalanx of the outer toe, and by fascia to the inner toe.

26. *Extensor digitorum communis*, ... 0·09

Distributed equally to both toes.

27. *Extensor carpi ulnaris*, ... 0·33

This important muscle, as in the Rhinoceros, actually flexes the wrist, though it represents the ulnar extensor; it is inserted by two tendons (of which one is common to the *flexor carpi ulnaris*) into the near end and inner side of the cannon bone. It takes its origin by a round tendon from the front of the outer condyle, inside the elbow joint, like the *tibialis anticus* and *extensor digitorum pedis*.

28. *Extensor ossis metacarpi pollicis*, ... 0·03

Arises from the ulna and interosseous membrane; and is inserted principally into the back of the phalanx of the inner toe.

XLV.—ON SOME INDENTED BONES OF THE CERVUS MEGACEROS, FOUND NEAR LOUGH GUR, CO. LIMERICK. BY A. CARTE, M. D., F. L. S.

(Plate V.)

[Read before the Royal Geological Society of Ireland, March 8, 1866.]

IT will be in the recollection of most of the Fellows that Mr. Jukes on a former occasion (December 9, 1863) laid before the Society a paper on a subject similar to that which I now have the honour to bring under your notice. The bones exhibited by Mr. Jukes were discovered underneath a bog, near the village of Legan, in the county of Longford; and in his paper he gave an accurate geological description of the locality where those remains were found. It will be remembered that in this case the bones were not seen in actual contact with each other *in situ* by Mr. Foot; and this part of the evidence rests on the testimony of Mr. Shaw, the owner of the ground.

My attention having been called to this interesting subject by Mr. Jukes' communication, in the course of the autumn of last year I had an opportunity of inquiring of Mr. William Hinchy, of Limerick—a man who has had great experience in finding and collecting the remains not only of the Megaceros, but of other sub-fossil animals, and who happened to be at that time in town, whether he had ever noticed such marks as formed the subject of discussion at the Society. He at once informed me that he had frequently seen such marks, but had never paid any special attention to them. I then requested him to send me up any marked bones which he might be fortunate enough to discover. Accordingly, I have received from him the specimens which are now laid on the table, and which consist of the following—viz., right humerus, right radius and ulna, right cannon or metatarsal bone, left radius and ulna, ditto tibia, ditto cannon or metatarsal, ditto calcis, and the palm of the left horn, indented or marked in two places.

I have received some information from my friend, Dr. Samuel Bennett, of Bruff, who was present on the day on which the marked bones were found. He says, in a letter, dated the 28th of February, 1865 :—"The place where the large heads have been found was at one time, I presume, a forest, as within the memory of the oldest inhabitants large ash trees have been cut down on the lands, and no doubt bog deal was found in the cutting of the turf. I am told that the surface of this place was covered with bog to a depth of some forty or fifty feet; and within the last forty years a depth of ten or twelve feet of bog was cut away, leaving the surface now on a level with the surrounding land. Strange to say, the deers' horns are still to be found from four to five feet or more below the present level. In some places the springs are so pressing on the workmen, that they are obliged to give up the work. At one side of this bog—no longer to be called so, as the place is covered with coarse grass in summer, and with water in winter—there are three hills, not very high—one called Knock Bullog, the second called Knock Strahane, and the third called Moohane."

The piece of ground where the bones were found is situated, as I learn from Dr. Bennett, on the left bank of the River Camoge, about one mile from Lough Gur, and is close to the ruined castle near Kilcullane House, townland of Kilcullane, parish of Herbertstown. It is about three-quarters of a mile long, and about three hundred yards wide. I learn from Mr. Hinchy that between August 15th and October 10th, 1864, twenty heads were found in this place; and about twenty-five years ago thirty or forty more were found in the same locality by those who were employed by Mr. John Abel, of Limerick, to search for them. The heads are discovered by probing the ground with a long iron rod, in a manner similar to that by which bogwood is found. Hinchy has found three in one hole from twenty to twenty-five feet in diameter, and I have further received from him some additional information relating to the position of the bones. He says that the marl in the district is very firm, cutting like cheese, and of a lightish colour. The head was found some four or five feet under the surface, and three feet in the marl, very firmly fixed. One foot of the top is composed of earthy stuff, with turf mould, on which coarse grass grows; the other four feet are rich marl; and underneath is a "bluish tough stuff," out of which you could scarcely pull the horns without damaging them. The head was found 100 feet from the foot of Knock Bullog, a hill about 250 feet high above the level of the bog. The place was quite dry and firm last summer; and Hinchy says that, though covered with water in winter, it dries and cracks very much by shrinkage in summer.

The first bone I shall call your attention to is the left metatarsal, or cannon bone, on the upper and outer surface of which there is a small, oval, highly polished depression, caused by the loss of the osseous tissue. The long axis of this, which is about one inch in length, corresponds to the long axis of the bone; its short axis, which is about $\frac{9}{16}$ of an inch, corresponds to its transverse diameter. The surface of this oval depression is concave in its long, and convex in its short axis. On the inner and lower fourth of the left tibia there is a similar oval highly polished mark or depression, with loss of bony substance; its long axis is inclined at an angle of about 45° to that of the shaft of the bone, its surface being convex in this direction. The short axis of this depression is also inclined, at an angle of about 45°, to the long axis of the bone, and its surface is concave. When these two depressions are brought into contact, they mutually fit into each other, the concave surface of one corresponding to the convex surface of the other. These bones, it would appear, lay across each other at an angle of about 45°. On the inner and upper third of the left radius there is a long oval highly polished mark with loss of osseous substance; it is two inches long by $\frac{9}{16}$ of an inch wide, its long axis running at an angle of about 30° to the long axis of the bone, and on the inner and upper third of the right metatarsal bone there is a similar highly polished depression, which fits accurately the depression on the left radius. On the upper, outer, and posterior aspect of the same metatarsal bone, the ridge which forms the external boundary of the groove for the tendons is worn into a concavity from above downwards for the distance of about 2¼ inches, and is highly polished; this surface fits accurately into a cut or groove which is situated on the inner surface of the left os calcis, the cut being about 2¼ inches long by $\frac{7}{16}$ of an inch wide, being convex in its long and concave in its short diameter.

The most remarkable of all, and that which throws the greatest light, if it does not indeed solve this interesting question, is the indentation, or cut, to speak more truly, on the outer and upper surface of the right radius and ulna (Plate V., Fig. 2); the former is deeply worn away, nearly exposing its medullary canal; it is scored as if by the action of a rope playing over and fretting it; the ulna is in a similar state. These surfaces are not, like the others, polished, but present a rather roughened appearance, as if they had been in contact with a substance composed of different densities. These two bones were discovered *in situ*, imbedded in a deep cut in the posterior edge of the palm of the left antler, into which they fit. (Plate V., Fig. 1). The right humerus on its inner, upper, and posterior aspect, just beneath the head of the bone, is deeply cut into, so deep that the medullary canal is exposed; this cut, like that on the radius and ulna, is not polished, but rough, in consequence of its cancelated structure being exposed. This bone, when *in situ*, was found in contact with the posterior and most distant tine of the left antler, a portion of which, about six inches long, it had severed from its connexion with the palm.

During the discussion which followed Mr. Jukes' paper I ventured to express the opinion that the phenomena were produced by the action of pressure and friction, and not by the former alone; and I apprehend that the explanation I then gave is fully borne out by the specimens now before you. The roughened state of the radius and ulna, before alluded to, was evidently produced by the unequal density of the cancelated structure of the horn acting on the surface of these bones through the medium of the fine particles of sand that enter into the composition of the marly bed in which they lay—the opposed surfaces of the bones, with the aid of the interposed sand, grinding each other away by the perhaps slow but long-continued motion of the surrounding boggy ground, which latter during the summer months contracts and sinks considerably, from the drying up of the soil producing a downward motion of the mass, whilst its upward motion is produced by the expansive force of cold and moisture during the winter season. This simple mechanical process of an alternate up and down motion will, I am inclined to think, fully explain the phenomena.

Dr. Carte then showed how accurately the bones fitted into the grooves, and how parts of them were polished. He said that in a former discussion upon a paper by Professor Jukes relating to bones of the *Cervus megaceros* found under circumstances similar to the present, the differences of opinion resolved themselves into three theories:—Mr. Jukes held that the abrasions were produced by simple pressure, and that there had been no such thing as friction; another theory was, that the marks were actually produced by the hand of man; the third theory was, that they were the result of the friction of the bones lying upon one another, that friction having been produced by motion for which it was not easy to assign a cause. The last was the doctrine that he himself broached, and he thought he would be able to show that his view was borne out in a very remarkable manner by the specimens now before them.

Dr. Battersby—Were the bones found lying close upon the horns in the way you have described?

Dr. Carte—Quite so. The man sent them up as he got them in the bog, marking the different parts which were in contact.

Professor Jukes said they must all be excessively obliged to Dr. Carte for these interesting specimens. It was evident that as the animal died, the bones in question fell in a confused mass to the bottom of some lake or water, and that lying upon one another they got abraded in the way that was seen. In the former discussion his sole point was that the marks could not have been produced by the hand of man, and that therefore the specimens then adduced could not be pointed to as evidence of the existence in Ireland of man contemporaneously with the *Cervus megaceros.* They knew that man did exist contemporaneously with that animal in England; and then arose the geological question, was Ireland at that time already separated from England and the Continent? Was the great plain which formerly connected the British Islands with the Continent already worn away, or had man already crossed over from England to Ireland? They knew that man existed in England probably before England was separated from the Continent. There was little difference between Dr. Carte and himself as to the exact cause of the indentations. Dr. Carte's idea was, that a little motion of the bones took place, and that friction was the consequence. For his part, he would be glad to be able to conclude that there had been friction; but the possibility of it seemed taken away by the facts stated in the paper, that the marl was like cheese, with clay and stones underneath it, and that the bones were so firmly imbedded in the marl that it was difficult to get the horns out without breaking them. It was difficult to conceive what motion there could have been with sixty feet of turf over the marl; but that was a physical question, on which he gave no opinion. The Knight of Kerry had suggested to him that great storms might have given a tremulous motion to the bog, which might have been transmitted downwards. Dr. Carte misunderstood him as to one point. He by no means supposed that the marks were caused merely by squeezing or pressure. What he did suggest was, that the parts squeezed might have been dissolved, and altogether removed. It was, satisfactory, however, with regard to the present specimens, that they did not for a moment admit the possibility of the indentations having been caused by the hand of man.

Dr. Frazer observed that at present red deer, in their search for food, often ran one after another into bogholes, and were smothered; and that there might have been marshy ground and a lake in this locality when these animals had lived there—perhaps three or four feet of marl, and a lake above it—into which the animals had fallen, and were drowned.

Mr. Scott observed that Hinchy, who had found the bones, had great experience in the discovery of specimens of the Megaceros; and that, when his attention had been directed to the circumstance that bones of this animal frequently exhibited markings, he at once said that he had often seen bones marked by lying together in the ground. He accordingly sent up the specimens now exhibited, and which were seen *in situ* not only by himself, but by Dr. Bennett, the gentleman who was with him on that day. It was certainly very remarkable that so many (upwards of seventy) heads had been discovered in so small a space within the last thirty years, and it appeared that there were still a good many left there.

Mr. Bolton was of opinion that the indentations had been caused by friction, resulting from motion of the bones against each other. He had seen the bough of a tree which was acted on by another piece of wood in water, in which there was a very slight motion, almost cut in two in a couple of days. The small, fine, sharp particles of the marl, getting between the bones, would have aided the process very much.

Captain Hutton observed that, as the two bones had cut into the antler in directions not parallel to each other, it was evident that no lateral motion of the antler could have taken place; and it was difficult to conceive any movement of the marl, or superjacent bog, which would give the two bones motions in different directions; and, as one of the bones appeared to have cut its way up, and the other down, it seemed to him that the markings must be due either to simple pressure, or to a slight vertical movement.

The Chairman was of opinion that, in the case of the bones from Legans, where the bones fell at first, there was then an open lake, without any bog or peat whatever near. The existing bed of marl in which they had been discovered was formed by the shells and *debris* of the animals that lived in the lake, and must have taken hundreds of years to accumulate. It was now covered by forty or fifty feet of bog, which extended for miles in every direction; and the subsequent formation of that bog must have taken even thousands of years. Portions of the bones in question which had projected into the peat rotted away; and the circumstance of their having been imbedded in the marl was what preserved the rest. He thought that pressure was the likeliest way of accounting for the indentations.

Dr. Macalister said, the great objection to the theory of pressure was that it would have shown the fibres of the bones bent, and not cut, as they appeared to have been. The polishing might be due to the fine particles of marl; but, if the latter had assisted in the cutting, the indentations and the bones corresponding to them would not fit as they did.

Captain Hutton said that, although a bog might shake at the top, there would be very little motion beneath its surface. It was well known that in a gale of wind the sea is quite still at eight or ten fathoms beneath the surface.

Mr. Good was decidedly in favour of the friction theory. The smallest motion in water causing friction, suppose of a broken mast or spar, against the side of a ship, would rapidly produce a cutting, the edges of which would be rough and jagged, or quite fine and smooth, according as the wood acted on was soft or hard.

Dr. Bennett observed, that what had been adduced at this meeting seemed to exclude the supposition of human hands having produced the indentations. He believed that, whatever was the force that did so, it must have been in action up to the very day the bones were found. He did not believe that such beautifully-polished surfaces as the bones exhibited could have been produced in a place saturated with water, and exposed to the deposit of mineral salts. There was no evidence that the bones were ever under running water. The only point that he referred to in last year's discussion was the supposition that the markings in the bones then exhibited were the result of disease. Dr. Carte's present specimens excluded that supposition altogether.

Mr. Brownrigg observed that the motion of the bones, while in the soft marl, might have been owing to variation in the weight of water over it, caused by the alternate floods of winter and droughts of summer, which would have produced successive compressions and relaxings. This action, going on for an immense number of years, might have been adequate to the production of the effects.

Dr. Carte replied briefly, saying that the gentlemen who had taken part in the discussion had answered each other, so that there was little left for him to say, excepting to express his satisfaction that the specimens which he submitted to them had given rise to so animated a discussion.*

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* "There is another *constant* 'up and down' motion nearly in *all* bogs, consequent upon the least vibration arising either from passing weights shaking the ground, storm, or any *wind* agitating trees or other objects upon the surface. It is always 'up and down;' for, the layers of the peat being horizontal, it is evident that the least disturbance produces motion in a line vertical to the planes of the layers *only;* and, indeed, I believe more of the density of the bottom layers of bogs is due to this constant percussive action driving the moisture to the surface than to the mere superincumbent weight of bog. This motion is easily perceived when driving over a bog road.

"W. HARTE, C. E."

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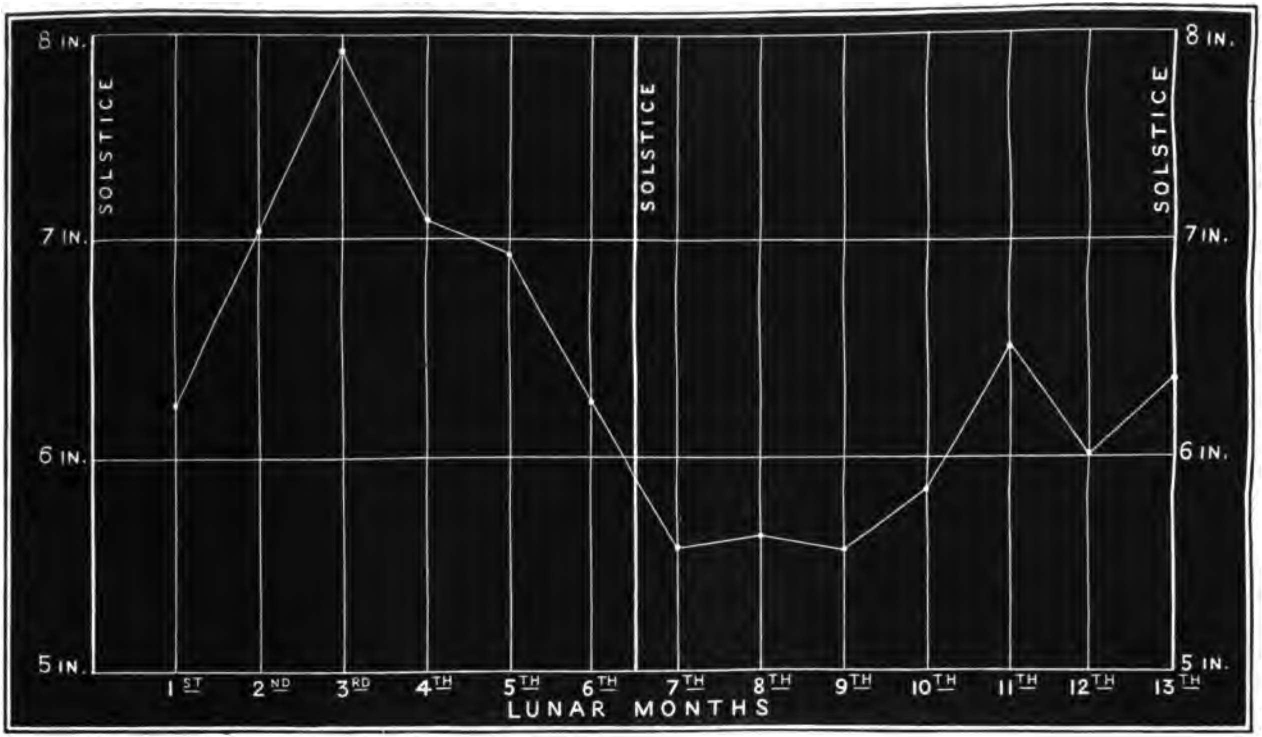
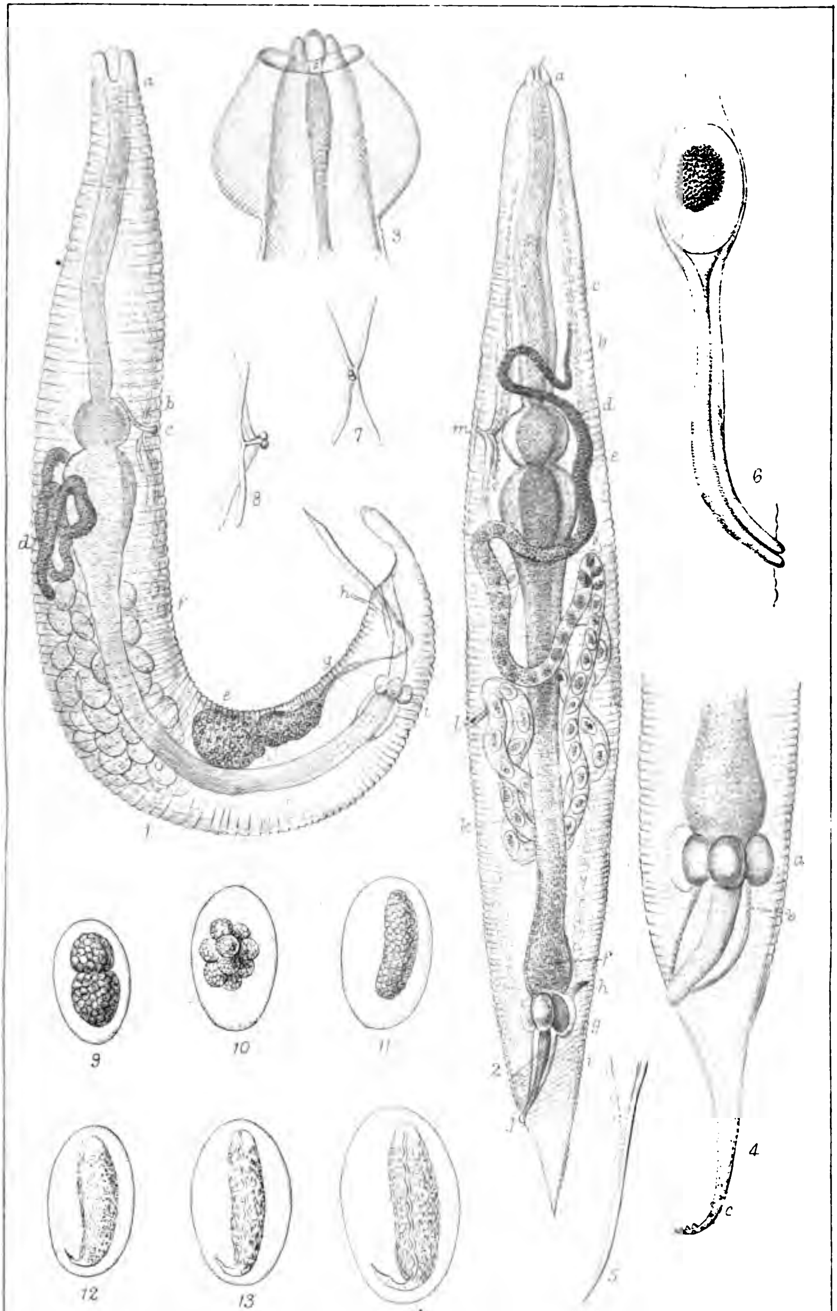


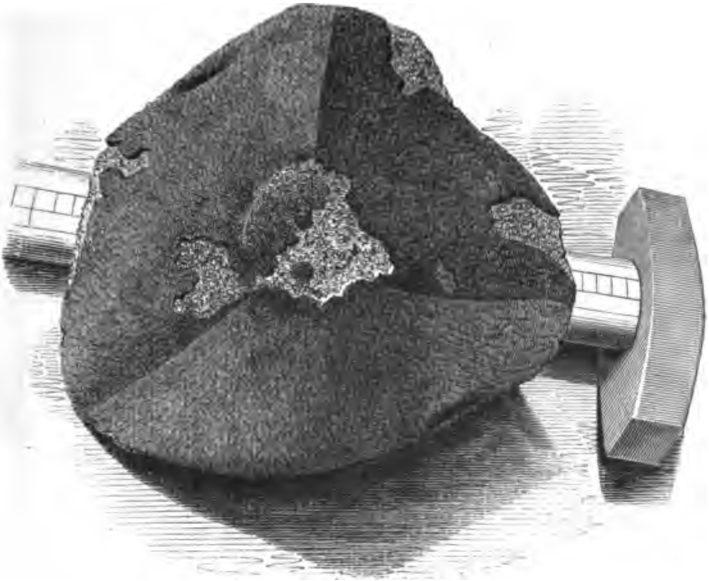
MEAN EVAPORATION AT ST. HELENA IN 1862, 3, 4.



A. Macalister del. Tuffen West sc.

W. West imp.

DUNDRUM METEORITE.



End View of the Dundrum Meteorite (12th August, 1865), showing the straight lines of the Crust, along the edges of Pyramid.

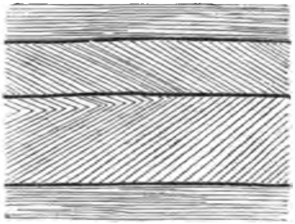


Fig. 1.

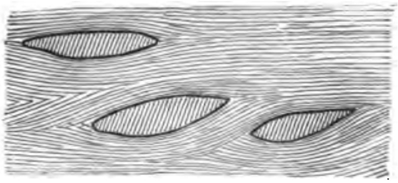


Fig. 2.

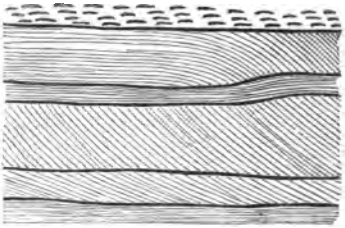


Fig. 3.

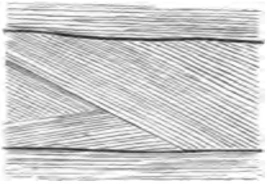
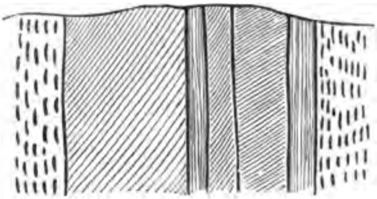


Fig. 4.



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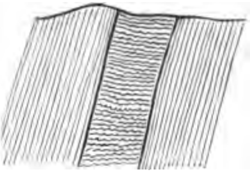
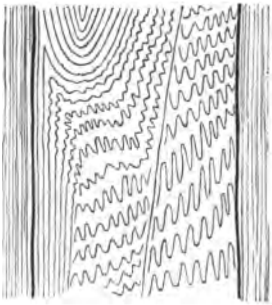


Fig. 6.



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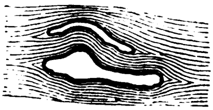

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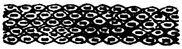
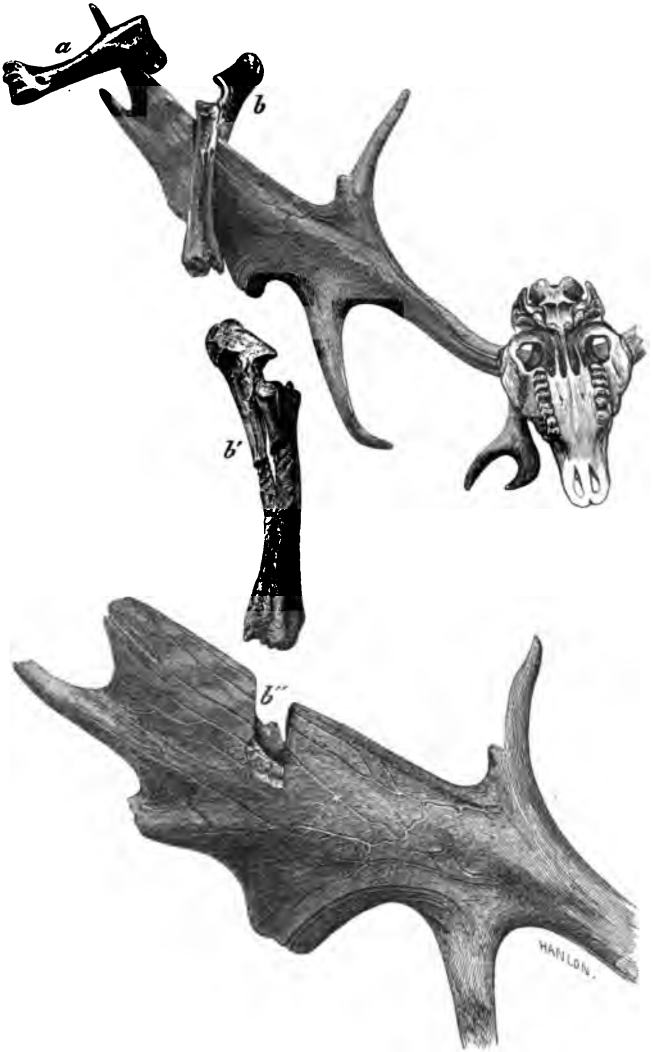


Fig. 9.

TO ILLUSTRATE MR. KINAHAN'S PAPER ON THE FOLIATION IN THE GNEISS AND SCHIST OF YAR-CONNAUGHT.

D.



a Humerus *in situ*.
b Radius and Ulna *in situ*.
b′ Radius and Ulna turned, so as to show indentation.
b′′ Cut in Antler, into which *b′* fitted.

TO ILLUSTRATE DR. CARTE'S PAPER ON INDENTED BONES OF THE CERVUS MEGACEROS.

DEC 3 188

APR ~~25 55~~ H